PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-319811
(43)Date of publication of application : 31.10.2002

(51)Int.Cl. H01Q 1/38
H01Q 5/01
H01Q 13/08
H01Q 21/30

(21)Application number : 2001-121411
(22)Date of filing : 19.04.2001

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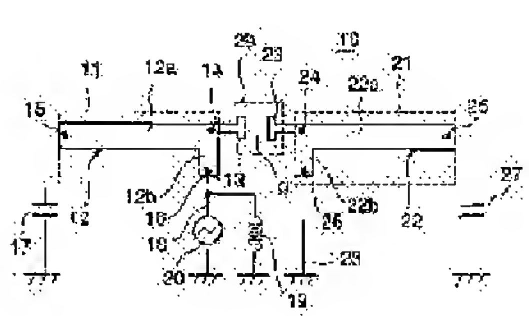
(54) PLURAL RESONANCE ANTENNA



(57)Abstract:
PROBLEM TO BE SOLVED: To provide a plural resonance antenna with an excellent plural resonance characteristic that can ensure the electric volume of the antenna.
SOLUTION: A feeding exciting element 11 and a non-feeding exciting element 21 of the antenna are respectively and individually configured.

The feeding exciting element 11 and the non-feeding exiting element 21 are electric-field- coupled by electric field coupling means 13, 23 provided separately. Through the configuration above, it is not required to configure the entire plural resonance antenna on one dielectric base. For example, each of the feeding exciting element 11 and the non-feeding exciting element 21 is respectively configured with the dielectric base, the electric field cooping means 13, 23 are formed on a conventional printed circuit board, the feeding exciting element 11 and the non-feeding exciting element 21 are interconnect to the electric field coupling means 13, 23 on the printed circuit board to realize the plural resonance antenna with an electric volume with a sufficient size.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]

[Claim 1] With the electric supply excitation child who comes to connect an electric-field joint terminal with the pars intermedia of the 1st radiation electrode which has an electric supply terminal at the end With the non-supplied electric power excitation child who comes to connect an electric-field joint terminal with the pars intermedia of the 2nd radiation electrode which has an earth terminal at the end The electric-field coupling means which is established apart from said electric supply excitation child and said non-supplied electric power excitation child, and combines the electric-field joint terminal of said electric supply excitation child and said non-supplied electric power excitation child by electric field, The double resonant antenna characterized by constituting from a feeder circuit which passes the signal current for said electric supply excitation child's electric supply terminal, and a grounded circuit which grounds said non-supplied electric power excitation child's earth terminal.

[Claim 2] Said electric supply excitation child and said non-supplied electric power excitation child have the base of the dielectric which forms a radiation electrode according to an individual. Said electric-field coupling means While constituting from an electric-field joint pattern of the pair which carried out opposite arrangement in the circuit board Said electric supply excitation child and said non-supplied electric power excitation child are laid on said circuit board. The double resonant antenna according to claim 1 characterized by having connected said electric supply excitation child's electric-field joint terminal to one [said] electric-field joint pattern, having connected said non-supplied electric power excitation child's electric-field joint terminal to the electric-field joint pattern of said another side, and constituting.

[Claim 3] The double resonant antenna according to claim 2 characterized by having carried out contiguity arrangement of the electric-field joint pattern of said pair, and giving a capacity component.

[Claim 4] The double resonant antenna according to claim 2 characterized by connecting a capacitor between the electric-field joint patterns of said pair.

[Claim 5] The double resonant antenna of any one publication of claim 1 characterized by having the adjustment combination current coupling means which adjusts the amount of currents which flows between said feeder circuits and said grounded circuits while adjusting the impedance

of said feeder circuit between said electric supply excitation child and said non-supplied electric power excitation child thru/or claim 4.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the double resonant antenna used for the mobile communication equipment which uses two or more frequencies.

[0002]

[Description of the Prior Art] In order for there to be some which carry out change ****** of the two frequencies by one set of a portable telephone in recent years in order to cancel confusion of a communication channel in mobile communication equipment, such as a portable telephone, and to use such two frequencies, it is required that it should have the function that the antenna carried in a portable telephone transmits and receives the electric wave of two frequencies. There is a double resonant antenna indicated by JP,9-260934,A in the example of such an antenna. By taking alignment with the digital signal frequency of 818MHz, and the analog signal frequency of 873MHz, this antenna covers two frequency bands, and as shown in drawing 13 , it is equipped with two excitation children excited on a different frequency.

[0003] In drawing 13 , on the base 2 made from the dielectric of one sheet, the double resonant antenna 1 excited on two frequencies forms spacing d, arranges two radiation electrodes 3 and 4 in parallel, and is constituted. The radiation electrodes 3 and 4 formed the other end side in the MIANDA configuration while using the end side as the tabular open ends 3a and 4a, they formed the touch-down sections 5 and 6 in the end

of the MIANDA configuration sections 3b and 4b, and have grounded these touch-down sections 5 and 6. Moreover, the electric supply section 7 was formed in the edge of MIANDA configuration section 3b, and this electric supply section 7 is connected to the radiation electrode 3 in the source 8 of a signal.
[0004] By this configuration, the radiation electrode 3 which receives supply of a signal from the source 8 of a signal serves as an electric supply excitation child, and the radiation electrode 4 which does not input a signal serves as a non-supplied electric power excitation child. The electromagnetic coupling (mainly electric-field association) of the radiation electrode 4 is carried out to the radiation electrode 3 through spacing d, and it excites an electric supply excitation child and a non-supplied electric power excitation child on a frequency different, respectively.
[0005]
[Problem(s) to be Solved by the Invention] However, since two radiation electrodes 3 and 4 are put side by side through spacing d on the base 2 of one sheet which consists of a dielectric, while a dielectric material with big surface area with a sufficient RF property is needed, the electric volume of an antenna is determined by the magnitude of the base 2 made from the dielectric. Therefore, although it is necessary to enlarge base 2 self for raising the property of an antenna, it is difficult for processing a big dielectric with a sufficient precision to secure the electric volume of a difficult and required antenna.
[0006] When the ceramic ingredient which was excellent as a dielectric material especially is used A dimensional tolerance becomes large for the contraction at the time of baking, and, in addition to it being difficult to produce a base with big surface area with sufficient dimensional accuracy, a ceramic ingredient is compared with the resin ingredient used for the circuit board. Since it is expensive, It cannot ** to lightweight-ization of the use device which the price of a base rose and could not manufacture an antenna cheaply, and was very heavy compared with the resin ingredient used for the circuit board as for the ceramic ingredient, and could not constitute an antenna lightweight, as a result incorporated the antenna.
[0007] This invention is accomplished in order to solve the above-mentioned technical problem, and the purpose is in securing the electric volume of an antenna and offering the good antenna of the double resonance characteristic.
[0008]
[Means for Solving the Problem] In order to attain the above-mentioned

purpose, this invention is taken as a means to solve said technical problem with the configuration shown below. With namely, the electric supply excitation child by whom the double resonant antenna of the 1st invention comes to connect an electric-field joint terminal with the pars intermedia of the 1st radiation electrode which has an electric supply terminal at the end With the non-supplied electric power excitation child who comes to connect an electric-field joint terminal with the pars intermedia of the 2nd radiation electrode which has an earth terminal at the end The electric-field coupling means which is established apart from an electric supply excitation child and a non-supplied electric power excitation child, and combines the electric-field joint terminal of an electric supply excitation child and a non-supplied electric power excitation child by electric field, It is characterized by constituting from a feeder circuit which passes the signal current for an electric supply excitation child's electric supply terminal, and a grounded circuit which grounds a non-supplied electric power excitation child's earth terminal.
[0009] In an above-mentioned configuration, while an electric supply excitation child resonates on the frequency of the electric wave used in response to supply of the resonance energy which is signal power through a feeder circuit from the source of a signal, a part of this energy is supplied to a non-supplied electric power excitation child through an electric-field coupling means, and it double-resonates a non-supplied electric power excitation child. Here, double resonance lives each other together, although an electric supply excitation child's return loss and a non-supplied electric power excitation child's return loss approach, and the condition that matching was able to be taken in the very extensive frequency band as a result is said.
[0010] Moreover, the electric-field coupling means is established separately from an electric supply excitation child and a non-supplied electric power excitation child, and determines the joint capacity between both excitation children. A good double resonant antenna property is acquired without direct electric-field association of an electric supply excitation child and a non-supplied electric power excitation child by setting up this joint capacity appropriately.
[0011] In the double resonant antenna of the 2nd invention, it sets to above-mentioned invention. An electric supply excitation child and a non-supplied electric power excitation child It has the base of the dielectric which forms a radiation electrode according to an individual. An electric-field coupling means While constituting from an electric-field joint pattern of the pair which carried out opposite arrangement

in the circuit board It is characterized by having laid the electric supply excitation child and the non-supplied electric power excitation child on the circuit board, having connected an electric supply excitation child's electric-field joint terminal to one electric-field joint pattern, having connected a non-supplied electric power excitation child's electric-field joint terminal to the electric-field joint pattern of another side, and constituting.

[0012] In this invention, since an electric supply excitation child and a non-supplied electric power excitation child are constituted using the base of a dielectric, respectively, a radiation electrode can be formed small and the excitation child itself is constituted small. This electric supply excitation child and a non-supplied electric power excitation child are carried and fixed to the circuit board which made the resin ingredient the subject, and association between an electric supply excitation child and a non-supplied electric power excitation child is performed by the electric-field joint pattern of the pair formed in the circuit board.

[0013] The both electric-fields joint pattern is arranged through predetermined spacing, and is carrying out electric-field association by the capacity component between electric-field joint patterns. The magnitude of a capacity component is decided by spacing of the part countered between electric-field joint patterns, the die length of an opposite part, an opposed face product, etc., and the magnitude of electric-field association between an electric supply excitation child and a non-supplied electric power excitation child is adjusted by adjusting the magnitude of this capacity component.

[0014] The double resonant antenna of the 3rd invention is characterized by having carried out contiguity arrangement of the electric-field joint pattern of a pair, and giving a capacity component in the 2nd configuration of invention.

[0015] According to this configuration, by setting the capacity component between electric-field joint patterns as the optimal range, the strength of electric-field association between an electric supply excitation child and a non-supplied electric power excitation child becomes settled the optimal, and an electric supply excitation child and a non-supplied electric power excitation child do actuation of the adjusted double resonance.

[0016] The double resonant antenna of the 4th invention is characterized by connecting a capacitor between the electric-field joint patterns of a pair in the 2nd configuration of invention.

[0017] In this invention, since the joint capacity between electric-

field joint patterns is decided as capacity value of a capacitor, the optimum coupling between an electric supply excitation child and a non-supplied electric power excitation child is easily obtained by choosing the value of a capacitor.
[0018] In above-mentioned invention [which], between an electric supply excitation child and a non-supplied electric power excitation child, the double resonant antenna of the 5th invention is characterized by having the adjustment combination current coupling means which adjusts the amount of currents which flows between a feeder circuit and a grounded circuit while it adjusts the impedance of a feeder circuit.
[0019] In this invention, while constituting an adjustment combination current coupling means so that the impedance between the source of a signal and an electric supply excitation child may be adjusted and supply of energy may be performed efficiently, it combines between a feeder circuit and grounded circuits in current, and serves to adjust the amount of currents which flows between an electric supply excitation child and a non-supplied electric power excitation child. Moreover, since the amount of currents of the current which flows a feeder circuit and a grounded circuit is large, in addition to current association, an adjustment combination current coupling means can be considered as the configuration which adjusts the amount of currents which flows to a non-supplied electric power excitation child also by field association.
[0020] In an above-mentioned configuration, an adjustment combination current coupling means can be constituted as an inductance circuit which has an inductance component. Since an inductance component serves as an impedance to a feeder circuit by setting up an inductance value suitably, the impedance of a double resonant antenna is certainly adjusted. Moreover, since this circuit wiring generates a field when an inductance circuit has circuit wiring of fixed die length, it becomes possible to adjust the amount of currents which flows to a grounded circuit by field association.
[0021] Moreover, the configuration in which a part of grounded circuit was made to approach a feeder circuit can be included in an adjustment combination current coupling means. The amount of currents which a grounded circuit and a feeder circuit carry out field association strongly, and flows to a grounded circuit by adoption of this configuration is adjusted.
[0022]
[Embodiment of the Invention] Below, the example of an operation gestalt concerning this invention is explained based on a drawing. Drawing 1 shows the basic configuration of the double resonant antenna concerning

this invention. The electric supply excitation child 11 and the non-supplied electric power excitation child 21 consist of strip radiation electrodes 12 and 22, respectively. These radiation electrodes 12 and 22 are formed using the conductor from the long pieces 12a and 22a and the short pieces 12b and 22b. The overall length (the die length of the sum of the long pieces 12a and 22a and the short pieces 12b and 22b) L of the radiation electrodes 12 and 22 is L=n-lambda/4, androotepsilon mostly, when specific inductive capacity of the part which formed lambda and the radiation electrodes 12 and 22 for the wavelength of the frequency in the electric wave to be used is set to epsilon. It has become. However, n is the natural number.

[0023] The electric-field coupling means 29 is formed between the electric supply excitation child 11 and the non-supplied electric power excitation child 21. This electric-field coupling means 29 consists of electric-field joint patterns 13 and 23 of the conductor of the pair which counters through the fixed spacing g. One electric-field joint pattern 13 is connected with the electric-field joint terminal 14 of the electric supply excitation child 11 who prepared in the radiation electrode 12, and the electric-field joint pattern 23 of another side is connected with the electric-field joint terminal 24 of the non-supplied electric power excitation child 21 who prepared in the radiation electrode 22. The electric supply excitation child 11 and the non-supplied electric power excitation child 21 do electric-field association through the electric-field joint patterns 13 and 23 of a pair.

[0024] Capacitors 17 and 27 are connected to the electric supply excitation child 11 and the non-supplied electric power excitation child 21, respectively between the open end sections 15 and 25 in the long pieces 12a and 22a of the radiation electrodes 12 and 22, and a gland. These capacitors 17 and 27 are usually given as stray capacity formed between the radiation electrodes 12 and 22 and a gland. Moreover, the electric supply excitation child's 11 electric supply terminal 16 is grounded through the inductor 19 while being prepared in the open end side of short piece 12b of the radiation electrode 12 and connecting with the source 20 of a signal of a feeder circuit 18. On the other hand, the non-supplied electric power excitation child's 21 earth terminal 26 is formed in the open end side of short piece 22b of the radiation electrode 22, and is grounded through the grounded circuit 28.

[0025] In this configuration, if the electric supply excitation child 11 receives the injection of sending-signal power from the source 20 of a signal, the resonance current of a RF flows to the radiation electrode

12, and signal power will be supplied also to the non-supplied electric power excitation child's 21 radiation electrode 22 through the electric-field joint patterns 13 and 23, and the resonance current of a RF will flow to the radiation electrode 22. Unlike the frequency f2 of the electric wave emitted by the non-supplied electric power excitation child 21, the frequency f1 of the electric wave emitted by the electric supply excitation child 11 usually becomes larger [a frequency f1] than a frequency f2. The electric-field joint patterns 13 and 23 of a pair are carrying out electric-field association of between the electric supply excitation child 11 and the non-supplied electric power excitation child 21, by changing the configuration of these electric-field joint patterns 13 and 23, change the amount of electric-field association, and adjust the double resonance characteristic of an antenna.
[0026] Moreover, capacitors 17 and 27 serve as a resonance circuit element which determines resonance frequency f1 and f2 in the electric supply excitation child 11 and the non-supplied electric power excitation child 21, and resonance frequency changes by changing the capacity value of capacitors 17 and 27. And an inductor 19 serves to adjust the impedance of an antenna to the source 20 of a signal, combines with the non-supplied electric power excitation child's 21 earth terminal 26 through a gland at coincidence, and has the function to adjust the amount of high frequency current which flows between the earth terminals 26 of the electric supply excitation child's 11 electric supply terminal 12b, and the non-supplied electric power excitation child 21.
[0027] Therefore, according to the above-mentioned double resonant antenna, it can consider as the optimal double resonance characteristic by constituting the electric-field joint patterns 13 and 23 appropriately, without changing the configuration of the electric supply excitation child 11 and the non-supplied electric power excitation child 21.
[0028] The equal circuit of the basic configuration of the above-mentioned double resonant antenna is shown in drawing 2 . In drawing 2 , the resonance inductance L1 and radiation resistance R1 express the radiation electrode 12, and the resonance inductance L2 and radiation resistance R2 express the radiation electrode 22. Moreover, the loading capacity C1 expresses the capacitor 17 connected to the electric supply excitation child 11, and the loading capacity C2 expresses the capacitor 27 connected to the non-supplied electric power excitation child 21.
[0029] These resonance inductance L1, radiation resistance R1, and the

loading capacity C1 form the electric supply excitation child's 11 resonance circuit, and the resonance inductance L2, radiation resistance R2, and the loading capacity C2 form the non-supplied electric power excitation child's 21 resonance circuit similarly. The joint capacity C12 between two resonance circuits expresses the electric-field joint patterns 13 and 23 of a pair, and electric-field association between the electric supply excitation child 11 and the non-supplied electric power excitation child 21 is capacity coupling equivalent. Moreover, the joint inductance L12 expresses the inductor 19, and adjusts the amount of currents which flows between two resonance circuits.

[0030] In order to realize good double resonance, maintaining the resonance frequency f1 and f2 of two resonance circuits so that clearly from this equal circuit, it is necessary to adjust the capacity value of the loading capacity C1 and C2 and the joint capacity C12. Joint capacity C12 can be considered as the loading capacity C1 and C2 and the well-balanced joint capacity C12 by setting up appropriately the die length of the spacing g of the electric-field joint patterns 13 and 23 of a pair, an opposed face product, and an opposite part. For example, in the case of the electric-field joint patterns 13 and 23 which formed the resin ingredient in the circuit board made into a subject, a trimming equipment can perform fine tuning of the die length of spacing g, an opposed face product, and an opposite part.

[0031] Moreover, the electric supply excitation child 11 and the non-supplied electric power excitation child 21 can constitute the loading capacity C1 and C2, and they mainly expresses the stray capacity between the radiation electrodes 12 and 22 in a ball, the electric supply excitation child 11, and the non-supplied electric power excitation child 21, and a gland as a concentrated constant.

[0032] In an above-mentioned equal circuit, if joint capacity C12 is enlarged, it will put in another way and electrostatic capacity between the electric-field joint pattern 13 and 23 will be enlarged, electric-field association between the electric supply excitation child 11 and the non-supplied electric power excitation child 21 will become strong, and resonance frequency f1 and resonance frequency f2 will not dissociate, as for the electric supply excitation child 11 and the non-supplied electric power excitation child 21, ** will also operate like one excitation child, and the return loss will become shallow. If the joint capacity C12 becomes small, it will put in another way contrary to this and electrostatic capacity between the electric-field joint pattern 13 and 23 will be made small, electric-field association between the electric supply excitation child 11 and the non-supplied electric power

excitation child 21 will become weak, and the frequency characteristics of strength and double resonance will no longer be acquired in the actuation which the electric supply excitation child 11 and the non-supplied electric power excitation child 21 became independent of, respectively.
[0033] Moreover, if loading capacity C1 and C2 is enlarged, the joint capacity C12 becomes small relatively, if it puts in another way, electric-field association in the electric-field joint patterns 13 and 23 will become weak, and the double resonance by resonance frequency f1 and f2 will not be obtained like ****. On the contrary, if loading capacity C1 and C2 is made small, the joint capacity C12 will become large relatively, and it will become that in which the capacity balance of an equal circuit collapsed. If it puts in another way, increase of the joint capacity C12 turns into increase of electric-field association in the electric-field joint patterns 13 and 23, and like ****, the resonance frequency f1 and f2 of the electric supply excitation child 11 and the non-supplied electric power excitation child 21 will approach, and it will not serve as double resonance.
[0034] Drawing 3 shows the concrete example of an operation gestalt concerning the double resonant antenna of this invention. In drawing 3 , the double resonant antenna 30 lays two antenna chips 41 and 51 in the circuit board 31 made considering the resin ingredient as a subject, and is constituted. Circuit wiring which antenna formation section 31a and grand section 31b are prepared in the front face, and does not illustrate the circuit board 31 in a rear face is formed. The grand layer which stuck and formed copper foil etc. on the insulating substrate is prepared in grand section 31b. The electric-field joint patterns 32 and 33 of the pair of an abbreviation T typeface counter antenna formation section 31a of the circuit board 31 through the fixed spacing g in a T character configuration part, and pattern formation is carried out to it with the conductor.
[0035] Moreover, pattern formation of the touch-down pattern 35 used as the electric supply pattern 34 and grounded circuit used as a feeder circuit is carried out to antenna formation section 31a. From the grand layer of grand section 31b, electric insulation of the electric supply pattern 34 is carried out, it is formed, and is connected to grand section 31b through the chip inductor 40. This electric supply pattern 34 is connected to the signal wiring which is not illustrated. Moreover, the touch-down pattern 35 is connected to the grand layer of grand section 31b.
[0036] The electric-field joint patterns 32 and 33, the electric supply

pattern 34, and the touch-down pattern 35 which were mentioned above are the same conductor as the grand layer of grand section 31b, and pattern formation is carried out at once by the approach of common knowledge, such as etching.
[0037] The antenna chips 41 and 51 equip the front face of the bases 43 and 53 of a dielectric with the radiation electrodes 42 and 52. The band-like electric-field joint terminals 44 and 54 are formed in the near edge (opposite edge) at which the radiation electrode 42 and the radiation electrode 52 counter. These electric-field joint terminals 44 and 54 hang the side face of bases 43 and 53, respectively, and a tip turns to the rear-face side of bases 43 and 53, and they are formed. And one electric-field joint terminal 44 is connected to the T character configuration part of the electric-field joint pattern 32, and the edge of the opposite side, and the electric-field joint terminal 54 of another side is connected to the T character configuration part of the electric-field joint pattern 33, and the edge of the opposite side.
[0038] Moreover, the band-like electric supply terminal 46 is formed, and this electric supply terminal 46 elongates the front face of a base 43 in the direction of a right angle to the electric-field joint terminal 44, and the side face of a base 43 is descended, and it turns to the rear-face side of a base 43, and is formed in the opposite edge of the radiation electrode 42. This electric supply terminal 46 is connected to the end of the electric supply pattern 34 prepared in the front face of the circuit board 31. By forming the band-like earth terminal 56 in the opposite edge of the radiation electrode 52, this earth terminal 56 elongates the front face of a base 53 in the direction of a right angle to the electric-field joint terminal 54, and it is prepared, and the side face of a base 53 is descended, and it turns, is formed in the rear-face side of a base 53, and connects with the touch-down pattern 35.
[0039] Furthermore, in the opposite side of the electric-field joint terminals 44 and 54, to the middle of the side face of bases 43 and 53, the open end sections 47 and 57 of the radiation electrodes 42 and 52 hang, and are formed, respectively. And the fixed-end children 48 and 58 are formed in the same side face in which these open end sections 47 and 57 were formed through fixed spacing to these open end sections 47 and 57. The fixed-end children 48 and 58 are elongated and formed to the rear face of bases 43 and 53, and are connected to the fixed patterns 36 and 37 formed in the circuit board 31.
[0040] In the above-mentioned concrete example of an operation gestalt, it connects with the sending circuit and receiving circuit which are not

illustrated, and the electric supply pattern 34 serves as a path of the high frequency current transmitted and received from the radiation electrodes 42 and 52. For example, a sending-signal current is supplied to the electric-field joint terminal 54 through the electric-field joint patterns 32 and 33 from the electric-field joint terminal 44, and excites the resonance circuit of the radiation electrode 52 while it flows into the radiation electrode 42 from the electric supply terminal 46 and excites the resonance current. At this time, the high frequency current flows towards a gland to an earth terminal 56.

[0041] The electric supply excitation child 41 and the non-supplied electric power excitation child 51 are doing electric-field association by the electric-field joint patterns 32 and 33, by changing the amount of electric-field association, can adjust association between the electric supply excitation child 41 and the non-supplied electric power excitation child 51, and can get good double resonance matching. The equivalent capacity of the electric-field joint patterns 32 and 33 is decided by the electric-field joint pattern 32, the spacing g between 33, and the die length of an opposite part.

[0042] Moreover, between the open end sections 47 and 57 of the radiation electrodes 42 and 52, and the fixed-end children 48 and 58, open end capacity is formed, respectively, and it works as a circuit element of the resonance circuit in the radiation electrodes 42 and 52, and becomes the element which determines the frequency of the resonance current which flows to the radiation electrodes 42 and 52.

[0043] Furthermore, the chip inductor 40 connected between the electric supply pattern 34 and grand section 31b adjusts the impedance of an antenna to the impedance of electric supply wiring, for example, 50 ohms, thereby, adjustment of the impedance between an antenna and the source 20 of a signal is acquired, and transmission and reception of a signal can make loss there be nothing. Moreover, it has combined with the touch-down pattern 35 electrically through grand section 31b, and the chip inductor 40 serves as a path of the high frequency current which flows between the electric supply excitation child 41 and the non-supplied electric power excitation child 51. The chip inductor 40 became the impedance of the current circuit between the electric supply excitation child 41 and the non-supplied electric power excitation child 51, and has determined the amount of current association between the electric supply excitation child 41 and the non-supplied electric power excitation child 51 here.

[0044] As mentioned above, by changing the configuration between the electric-field joint pattern 32 and 33, the amount of electric-field

association between the electric supply excitation child 41 and the non-supplied electric power excitation child 51 can be determined, and the double resonance characteristic of an antenna can be adjusted. Moreover, by choosing the inductance value of the chip inductor 40, while adjusting the impedance of the antenna to electric supply Rhine, the amount of current association between the electric supply excitation child 41 and the non-supplied electric power excitation child 51 can be adjusted.

[0045] In the above-mentioned example of an operation gestalt, in addition, the radiation electrodes 42 and 52 of the electric supply excitation child 41 and the non-supplied electric power excitation child 51 Since it formed in the configuration of the field symmetry, in case the radiation electrodes 42 and 52 are formed by screen-stencil etc., for example, to the non-supplied electric power excitation child's 51 radiation electrode 52 Since the reverse pattern of the mask used with the electric supply excitation child's 41 radiation electrode 42 can be used, the manufacturing cost of the chip antennas 41 and 51 can be reduced.

[0046] Moreover, although only the electric-field joint patterns 32 and 33, the electric supply pattern 34, the touch-down pattern 35, and the fixed patterns 36 and 37 are formed in antenna formation section 31a of the circuit board 31 and a grand layer does not exist in it in the above-mentioned example of an operation gestalt, the fixed patterns 36 and 37 may be lengthened and you may connect with the grand layer of grand section 31b. These are decided in consideration of the antenna double resonance characteristic.

[0047] Furthermore, in the above-mentioned example of an operation gestalt, the chip antennas 41 and 51 can define the array freely at the time of a design, although the longitudinal direction is arranged in the shape of a straight line. For example, it may arrange in the shape of a right angle, and the longitudinal direction of the chip antennas 41 and 51 may lean [as opposed to / in arrange **** / another side] the chip antennas 41 and 51 mutually, for example, may arrange one side into Ha's handwriting so that a longitudinal direction may become parallel [the chip antennas 41 and 51].

[0048] Since the arrangement of the chip antennas 41 and 51 which formed the electric-field joint patterns 32 and 33 in the circuit board 31, become realizable for the first time by the configuration which carries out electric-field association, and aligned two chip antennas 41 and 51 with the case of a wireless device by this using these electric-field joint patterns 32 and 33 of free arrangement of such chip antennas 41

and 51 is attained, the degree of freedom of a double resonant antenna design increases.
[0049] Furthermore, in the above-mentioned example of an operation gestalt, in the double resonance state, since it has the original resonance frequency f1 and f2, as for the chip antennas 41 and 51, the dimension may be mutually different, and the specific inductive capacity of bases 43 and 53 can also make the chip antennas 41 and 51 mutually different, and the formation front face of the radiation electrodes 42 and 52 also of the configuration of bases 43 and 53 may be not only a rectangle but a square again.
[0050] Furthermore, in the above-mentioned example of an operation gestalt, although two chip antennas 41 and 51 made the configuration of the radiation electrodes 42 and 52 the field symmetry, as for this, they may be unsymmetrical, for example, may form one radiation electrode in tabular, and may form the radiation electrode of another side in a MIANDA configuration again. Moreover, when forming the radiation electrodes 42 and 52 of two chip antennas 41 and 51 in a MIANDA configuration, it can design freely one side being able to elongate the radiation electrode of the letter of a ** face crease to the longitudinal direction on the front face of a base, and being able to consider another side as the configuration elongated in the direction of a short hand on the front face of a base, and using one side as the radiation electrode of the letter of a ** face crease, and using another side as a curled form radiation electrode etc. Therefore, also in case the radiation electrodes 42 and 52 of two chip antennas 41 and 51 are formed, the degree of freedom of a design becomes large.
[0051] the above -- in [any] the case of the example of an operation gestalt, since the large field as a double resonant antenna can be taken even if an electric supply excitation child and a non-supplied electric power excitation child constitute small by using the circuit board, the electric volume of an antenna increases and the double resonant antenna of a large high interest profit of frequency bandwidth can be manufactured cheaply.
[0052] The example of an operation gestalt shown in drawing 4 thru/or drawing 6 shows other configurations which combine electrically an electric supply excitation child and a non-supplied electric power excitation child, and gives the same sign to the same component as the example of an operation gestalt of drawing 3 , and duplication explanation of the intersection is omitted.
[0053] In drawing 4 , the electric-field joint pattern 61 which connects the electric supply excitation child 41 is formed in the front face of

antenna formation section 31a in the circuit board 31, and the electric-field joint pattern 62 which connects the non-supplied electric power excitation child 51 is formed in the rear face of the circuit board 31. The amount of [of the electric-field joint patterns 61 and 62] point has lapped up and down through the circuit board 31, between the electric-field joint pattern 61 and 62, the joint capacity according to the thickness and the opposed face product of the circuit board 31 occurs, and it carries out capacity coupling of between the electric supply excitation child 41 and the non-supplied electric power excitation child 51.
[0054] This joint capacity can be changed by changing the opposed face product of the electric-field joint patterns 61 and 62. Moreover, the non-supplied electric power excitation child's 51 electric-field joint terminal 54 is connected to the junction pattern 63 prepared in the front-face side of the circuit board 31, and this junction pattern 63 is connected to the electric-field joint pattern 62 through a through hole 64.
[0055] The example of an operation gestalt shown in drawing 5 is different from the example of an operation gestalt of drawing 4 at the point which has stationed the non-supplied electric power excitation child 51 to the rear-face side of the circuit board 31. The non-supplied electric power excitation child's 51 electric-field joint terminal is connected to the direct electric-field joint pattern 62 like drawing 3 . The fixed pattern 66 is formed in the rear face of the circuit board 31, and the non-supplied electric power excitation child's 51 fixed-end child 58 is connected to this fixed pattern 66. By this configuration, the space on the rear face of front of antenna formation section 31a in the circuit board 31 is used effectively.
[0056] Moreover, two electric-field joint patterns 68 and 69 are combined by the capacitor 70 instead of the example of an operation gestalt of drawing 6 arranging two electric-field joint patterns 68 and 69 as an electric-field coupling means 29 through spacing in which joint capacity is formed. A chip capacitor is used for a capacitor 70. Between the electric supply excitation child 41 and the non-supplied electric power excitation child 51, it is combined by the capacitor 70 by this configuration, and the degree of coupling between the electric supply excitation child 41 and the non-supplied electric power excitation child 51 is changeable by changing the capacity value of a capacitor 70 with a configuration.
[0057] The example of an operation gestalt shown in drawing 7 thru/or drawing 11 shows other configurations which adjust the amount of current

association between an electric supply excitation child and a non-supplied electric power excitation child while adjusting the impedance of a double resonant antenna to the source of a signal, and it gives the same sign to the same component as the example of an operation gestalt of drawing 3 , and duplication explanation of the intersection is omitted.

[0058] In drawing 7 and drawing 8 , it replaces with the inductance circuit which used the chip inductor 40 of drawing 3 , and the electrode pattern 71 which connected the end to the electric supply terminal 46 is formed in the side face of the electric supply excitation child's 41 base 43. The other end of this electrode pattern 71 is connected to the grand layer of grand section 31b through the connection pattern 72 formed in antenna formation section 31a of the circuit board 31. The electrode pattern 71 is formed in a MIANDA configuration, and an inductance component is given.

[0059] In this configuration, the impedance of a double resonant antenna is adjusted by the inductance value of the electrode pattern 71 to the source of a signal like the chip inductor 40 of drawing 3 . Moreover, the connection pattern 72 is electrically combined with the touch-down pattern 35 through grand section 31b, current association is carried out through the impedance of the electrode pattern 71 between the electric supply excitation child 41 and the non-supplied electric power excitation child 51, and the amount of currents which flows between the electric supply excitation child 41 and the non-supplied electric power excitation child 51 is adjusted. In this case, when the connection pattern 72 and the touch-down pattern 35 approach and are prepared, the amount of currents which flows the touch-down pattern 35 also by field association can be decided.

[0060] According to the above-mentioned configuration, since it is formed in the front face of the base 43 in the electric supply excitation child 41, when producing the electric supply excitation child 41, the electrode pattern 71 can be formed by the same manufacture approach as formation of the radiation electrode 42, and can form the connection pattern 72 in the circuit board 31 at formation and coincidence of the electric supply pattern 34 and the touch-down pattern 35.

[0061] The example of an operation gestalt of drawing 9 is different from the example of an operation gestalt of drawing 7 at the point prepared in the circuit board 31 instead of preparing the pattern which has an inductance component in the base 43 of the antenna chip 41. In addition, in order to show the configuration of invention clearly, the

dotted line shows the chip antennas 41 and 51. The inductance pattern 73 of a MIANDA configuration connected with the electric supply pattern 34 as an inductance circuit is formed in the front face of antenna formation section 31a of the circuit board 31.

[0062] The inductance value of the inductance pattern 73 is set as the value from which the transceiver signal power from a double resonant antenna serves as max. Moreover, the inductance pattern 73 is connected to the grand layer of grand section 31b near the touch-down pattern 35, and the inductance pattern 73 and the touch-down pattern 35 carry out field association with current association.

[0063] That is, since the amount of currents which flows the inductance pattern 73 and the touch-down pattern 35 is large, the magnetic field strength generated from these patterns 35 and 73 becomes large. Also in this case, like ****, the inductance pattern 73 determines two chip antennas 41 and the amount of current association between 51 while adjusting an impedance, and also it adjusts two chip antennas 41 and the amount of currents which flows between 51 with the amount of field association.

[0064] The example of the drawing 10 operation gestalt gives the means of field association between the chip antenna 41 and 51 to the example of an operation gestalt shown in drawing 3 . In addition, the dotted line shows the chip antennas 41 and 51. Bend 74a is prepared in the touch-down pattern 74 which connects the earth terminal 56 of the chip antenna 51, the electric supply pattern 34 is approached, and it connects with the grand layer of grand section 31b.

[0065] According to this configuration, in addition to the adaption function by the chip inductor 40 mentioned above, to the electric supply pattern 34 and the touch-down pattern 74, field association arises from there being many amounts of currents which flow to the electric supply pattern 34, and the chip antenna 41 and the amount of currents which flows between 51 can be adjusted. Moreover, the joint degree between the touch-down pattern 74 and the electric supply pattern 34 is changeable by changing the gestalt of bend 74a.

[0066] Moreover, drawing 11 is two chip antennas 41 and the example of an operation gestalt which prepared the inductor among 51 and carried out direct current association. In addition, the dotted line shows the chip antennas 41 and 51. The electric supply drawer patterns 75 are formed successively, from the touch-down pattern 35, the touch-down drawer pattern 76 is pulled out to the electric supply pattern 34 formed in the circuit board 31, and the inductor 77 is connected to it between this electric supply drawer pattern 75 and the touch-down drawer pattern

76. Moreover, the chip antenna 41 and the electric-field joint patterns 78 and 79 which carry out electric-field association of between 51 have constituted and countered the abbreviation L typeface.
[0067] With this configuration, by selecting the inductance value of an inductor 77, the impedance matching of the double resonant antenna to the source of a signal, two chip antennas 41, and the amount of currents that flows between 51 can be adjusted directly, and the design of a double resonant antenna becomes easy about it by the inductor 77. Moreover, although electric-field association by the electric-field joint patterns 78 and 79 becomes weak compared with the electric-field joint patterns 32 and 33 of the abbreviation T typeface of the example of an operation gestalt shown in drawing 3 , the configuration of the electric-field joint patterns 78 and 79 is decided in consideration of adjustment with direct current association by the inductor 77.
[0068] By adoption of an above-mentioned configuration, the electric supply pattern 34 and the touch-down pattern 35 carry out current association directly through an inductor 77. With the inductance value, an inductor 77 determines the amount of currents which flows between the electric supply pattern 34 and the touch-down patterns 35 while adjusting the impedance between a double resonant antenna and the source of a signal.
[0069] The example of the drawing 12 operation gestalt shows the configuration of 2 ****** resonant antenna which put side by side two double resonant antennas of the example of an operation gestalt shown in drawing 3 on the one circuit board. The chip antennas 81 and 82 are a pair of chip antennas which produce double resonance, and are chip antennas used as the pair from which the chip antennas 91 and 92 also produce double resonance. Electric-field association of the chip antennas 81 and 82 is carried out through the electric-field joint patterns 83 and 84, and electric-field association also of the chip antennas 91 and 92 is carried out through the electric-field joint patterns 93 and 94.
[0070] The chip antennas 81 and 91 are connected to the common electric supply pattern 85, and signal power is supplied to coincidence from the source of a signal. The inductor 86 is connected with the common electric supply pattern 85 between the grand layers of grand section 31b, and the impedance of two double resonant antennas is adjusted to the source of a signal. Moreover, two chip antennas 82 and 92 are connected to the grand layer of grand section 31b through the touch-down patterns 87 and 88, respectively.
[0071] In this configuration, the frequency band of the double resonance

by the chip antennas 81 and 82 and the double resonance by the chip antennas 91 and 92 is detached and set up. For example, when the chip antennas 81 and 82 double-resonate with the frequency band which is 800-900MHz, the chip antennas 91 and 92 are set up so that it may double-resonate with a 1700-2100MHz band. If it puts in another way, two or more double resonant antennas which can be set to the frequency band which separated to extent which does not produce interference mutually can be designed using the common circuit board.
[0072]
[Effect of the Invention] Since the electric-field coupling means which combines between both excitation children apart from an electric supply excitation child and a non-supplied electric power excitation child was established according to the double resonant antenna of claim 1, the double resonant antenna which was excellent in the frequency characteristics in reflection loss can be obtained by optimizing electric-field association between both excitation children. And by setting up the configuration of an electric-field coupling means suitably, it can respond to expansion of the dimension of the whole antenna flexibly, and the electric volume of an antenna can be increased, without changing the configuration of an electric supply excitation child and a non-supplied electric power excitation child.
[0073] Moreover, since an electric-field coupling means is formed independently of an electric supply excitation child and a non-supplied electric power excitation child, the degree of freedom of a design of an antenna can offer the antenna which can bear enough the application of increase and large power transmission and reception. Furthermore, since space including an electric supply excitation child, a non-supplied electric power excitation child, and an electric-field coupling means can be used as electric volume of the whole antenna, the antenna of a broadband and high interest profit is realizable.
[0074] According to the double resonant antenna of claim 2, since the electric-field joint pattern of a pair was prepared independently of the electric supply excitation child and the non-supplied electric power excitation child, the amount of electric-field association between an electric supply excitation child and a non-supplied electric power excitation child can be adjusted by adjusting the capacity between electric-field joint patterns.
[0075] Although the electromagnetic coupling between both excitation children is adjusted in the former by changing the configuration of an electric supply excitation child and a non-supplied electric power excitation child Since capacity coupling between the electric-field

joint patterns of the pair formed in the circuit board adjusts the amount of electric-field association between an electric supply excitation child and a non-supplied electric power excitation child in this invention while being able to choose freely the arrangement gestalt of an electric supply excitation child and a non-supplied electric power excitation child, you may differ, even if the configuration, dimension, and dielectric constant of the base which constitutes an excitation child are also the same as mutual, and the configuration and orientation of a radiation electrode do not receive a limit at all, either.

[0076] Therefore, since it is possible to perform the frequency of a double resonant antenna and adjustment of a delta frequency by the electric-field joint pattern, the design of the increase of the degree of freedom of a double resonant antenna design and a double resonant antenna becomes easy. Since the electric-field joint pattern formed on the circuit board performs the degree of electric-field association especially, the double resonant antenna of the application which transmits and receives an electric wave with large power is producible.

[0077] Moreover, the base of a dielectric is used only for the parts of an electric supply excitation child and a non-supplied electric power excitation child, and since the electric-field joint pattern which carries out electric-field association of an electric supply excitation child and the non-supplied electric power excitation child was constituted on the circuit board, unlike the antenna with which the whole double resonant antenna consists of bases of a dielectric, it can carry out the design which changed the dimension of a double resonant antenna flexibly like before.

[0078] Since the base of a ceramic ingredient is used only for the parts of an electric supply excitation child and a non-supplied electric power excitation child and it is not necessary to use the base of the ceramic ingredient of the big dimension as a dielectric for the whole double resonant antenna when the dielectric of a double resonant antenna is especially constituted from a ceramic ingredient, an electric supply excitation child and a non-supplied electric power excitation child can be produced with sufficient process tolerance, and a double resonant antenna can be made cheaply and lightweight.

[0079] Furthermore, since a degree of freedom is in each arrangement of an electric supply excitation child and a non-supplied electric power excitation child, according to the case of the mobile communication equipment with which a double resonant antenna is incorporated, it can opt for arrangement of an electric supply excitation child and a non-supplied electric power excitation child flexibly. Even in such a case,

since the whole field containing an electric supply excitation child, a non-supplied electric power excitation child, and an electric-field joint pattern is used as electric volume of a double resonant antenna, the double resonant antenna of a large high interest profit of frequency bandwidth is realizable.

[0080] Since an electric-field joint pattern is prepared in the circuit board independently of an electric-supply excitation child and a non-supplied electric power excitation child according to the double resonant antenna of claim 3, it can consider as various pattern configurations, without taking into consideration the configuration of an electric-supply excitation child and a non-supplied electric power excitation child, and a setup of the resonance frequency of an electric supply excitation child and a non-supplied electric power excitation child in double resonance and adjustment of the delta frequency between an electric-supply excitation child and a non-supplied electric power excitation child become that it is easy.

[0081] According to the double resonant antenna of claim 4, since between electric-field joint patterns is combined by the capacitor, it can consider as the optimal double resonant antenna by choosing the value of a capacitor.

[0082] According to the double resonant antenna of claim 5, since the adjustment combination current coupling means was prepared between the electric supply excitation child and the non-supplied electric power excitation child, it is easy in impedance matching with the source of a signal, and also when increasing the electric volume of an antenna, a flexible design becomes possible, without between an electric supply excitation child's and a non-supplied electric power's excitation child field being combinable and combinable, and taking into consideration the arrangement relation between an electric supply excitation child and a non-supplied electric power excitation child.

[0083] Moreover, since an adjustment combination current coupling means can be designed separately from an electric supply excitation child and a non-supplied electric power excitation child, the dimension of a double resonant antenna can be set up freely, without deforming the configuration of an electric supply excitation child and a non-supplied electric power excitation child, and the double resonant antenna suitable for the application of large power transmission can be obtained.

[0084] Furthermore, with the impedance of this inductance circuit, when an adjustment combination current coupling means is constituted from an inductance circuit, while being able to adjust the impedance of the double resonant antenna to a feeder circuit, even if the amount of

currents which flows between an inductance circuit and a grounded circuit is large, the amount of currents can be adjusted certainly. Moreover, the amount of currents which flows to a grounded circuit also by field association can be adjusted by approaching and arranging circuit wiring of an inductance circuit in a grounded circuit.
[0085] Furthermore, when an adjustment combination current coupling means includes the configuration in which a part of grounded circuit was made to approach a feeder circuit again, while being able to adjust the amount of currents which flows to a grounded circuit by field association, the joint degree between a grounded circuit and a feeder circuit is changeable by adjusting an adjustment combination current coupling means.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the basic configuration of the double resonant antenna concerning this invention.
[Drawing 2] It is the representative circuit schematic of the double resonant antenna shown in drawing 1.
[Drawing 3] the concrete configuration of the double resonant antenna concerning this invention is shown, (A) can be set in a top view and (B) can be set to alternate long and short dash line X-X of (A) -- it is a cross-section side elevation a part.
[Drawing 4] other configurations of the double resonant antenna concerning this invention are shown -- it is a cross-section side elevation a part.
[Drawing 5] the configuration of further others of the double resonant antenna concerning this invention is shown -- it is a cross-section side

elevation a part.
[Drawing 6] It is the part plan showing other configurations of the double resonant antenna concerning this invention.
[Drawing 7] It is the part plan showing other configurations of the double resonant antenna concerning this invention.
[Drawing 8] It is the perspective view of the chip antenna used for the double resonant antenna concerning this invention.
[Drawing 9] It is the part plan showing the configuration of further others of the double resonant antenna concerning this invention.
[Drawing 10] It is the part plan showing the configuration of further others of the double resonant antenna concerning this invention.
[Drawing 11] It is the part plan showing the configuration of further others of the double resonant antenna concerning this invention.
[Drawing 12] It is the top view showing the configuration of 2 ****** resonant antenna concerning this invention.
[Drawing 13] It is the perspective view showing the conventional double resonant antenna.
[Description of Notations]
10 30 Double resonant antenna
11 Electric Supply Excitation Child
12, 22, 42, 52 Radiation electrode
13, 23, 32, 33, 61, 62, 68, 69 Electric-field joint pattern
14, 24, 44, 54 Electric-field joint terminal
15, 25, 47, 57 Open end section
16 46 Electric supply terminal
17 27 Open end capacity
18 Feeder Circuit
19 77 Inductor
20 Source of Signal
21 Non-Supplied Electric Power Excitation Child
26 56 Earth terminal
28 Grounded Circuit
31 Circuit Board
31a Antenna formation section
31b Grand section
34 Electric Supply Pattern
35 74 Touch-down pattern
36, 37, 66 Fixed pattern
40 Chip Inductor
41 51 Chip antenna
43 53 Base

42a Flat-surface section
42b MIANDA configuration section
48 58 Fixed-end child
63 Junction Pattern
64 Through Hole
70 Capacitor
71 Electrode Pattern
72 Connection Pattern
73 Inductance Pattern
74a Bend
75 Electric Supply Drawer Pattern
76 Touch-down Drawer Pattern

[Translation done.]

* NOTICES *

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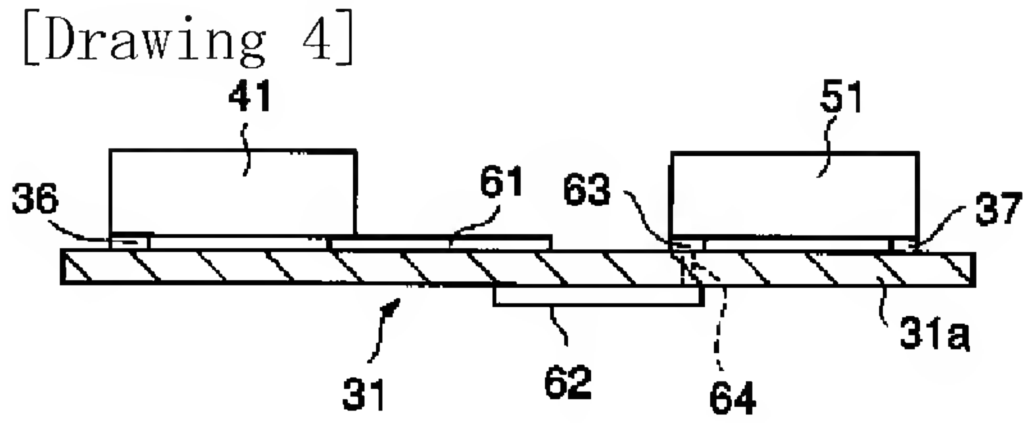
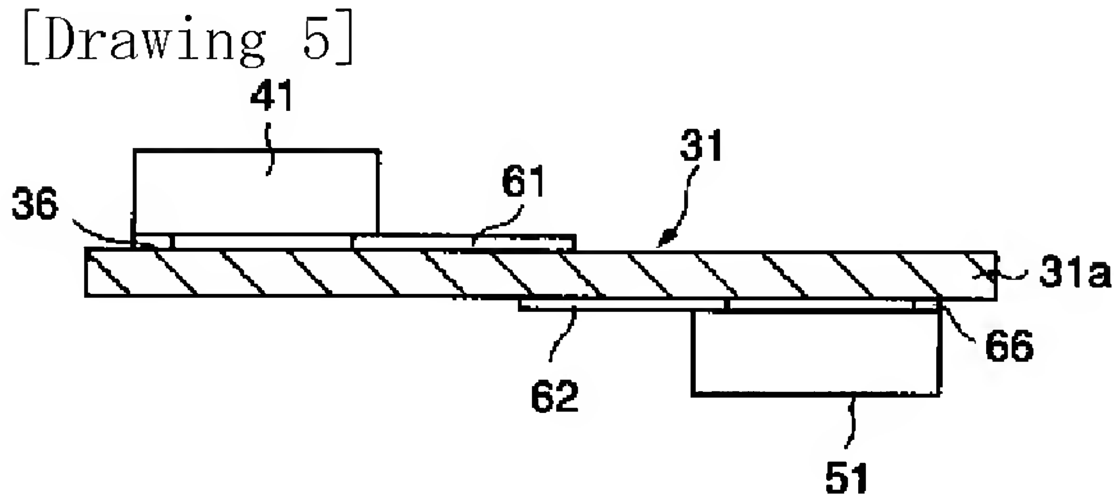
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

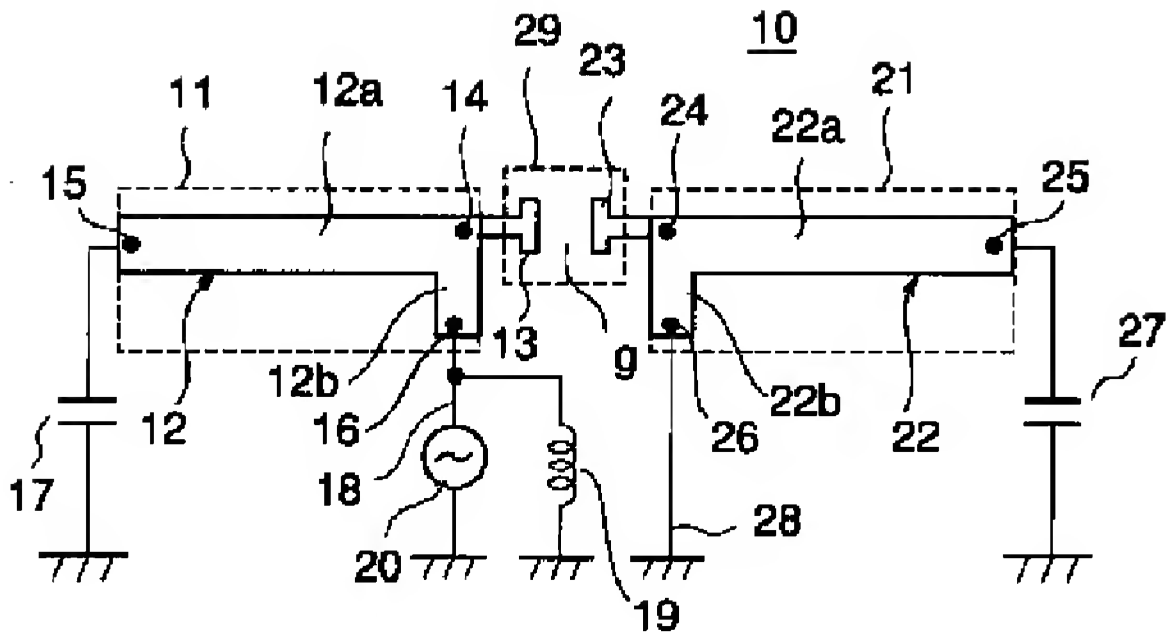
[Drawing 4]



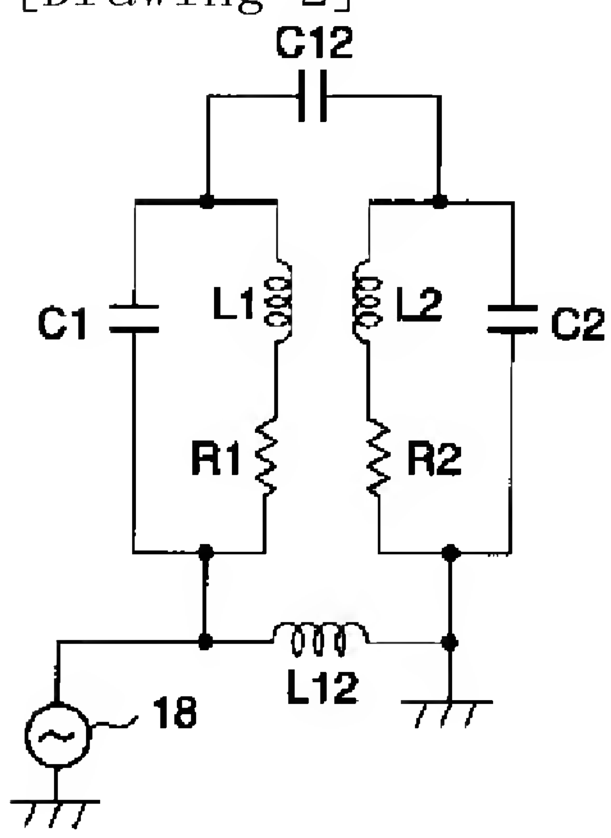
[Drawing 5]



[Drawing 1]

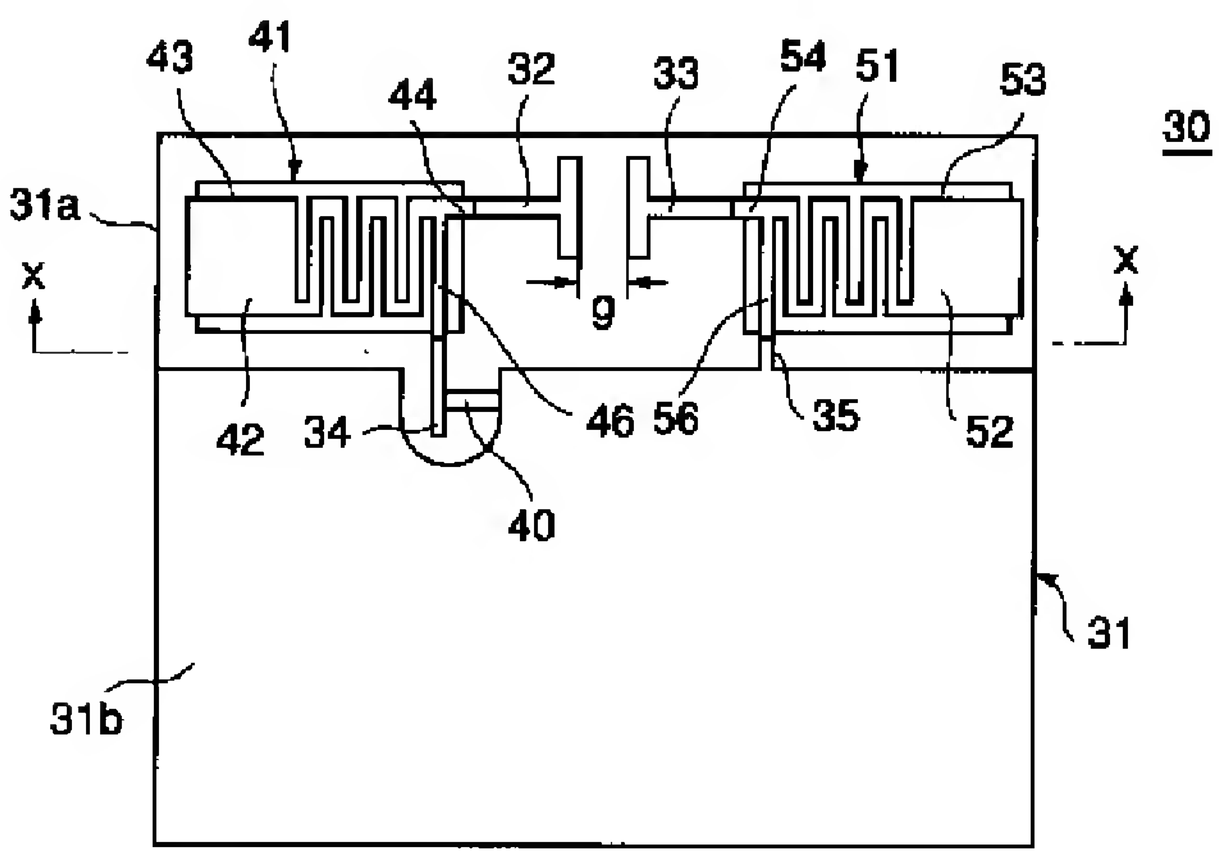


[Drawing 2]

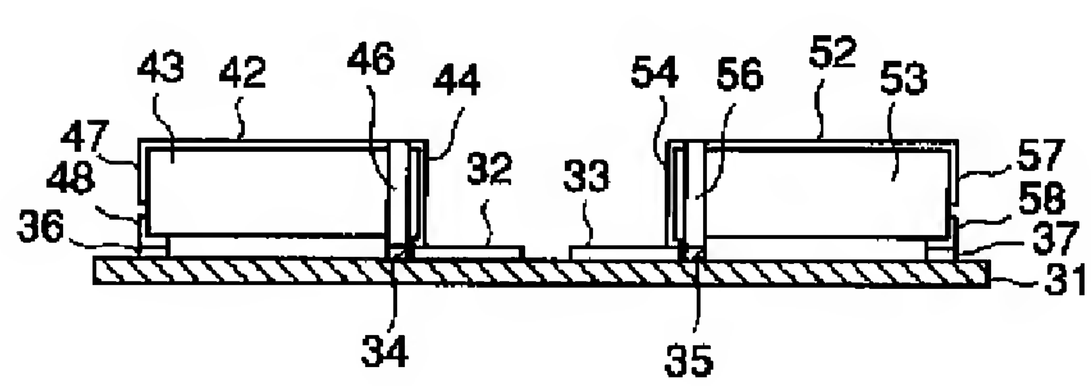


[Drawing 3]

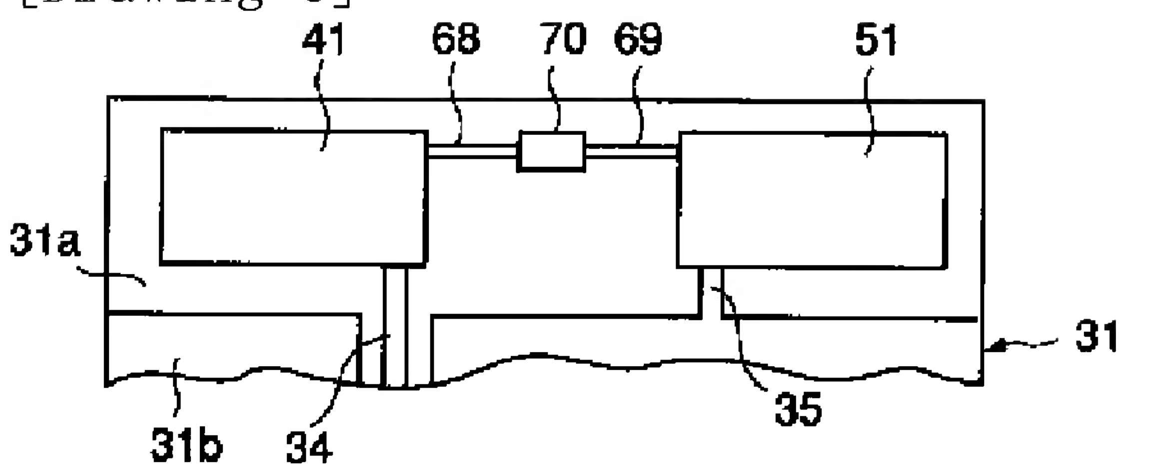
(A)



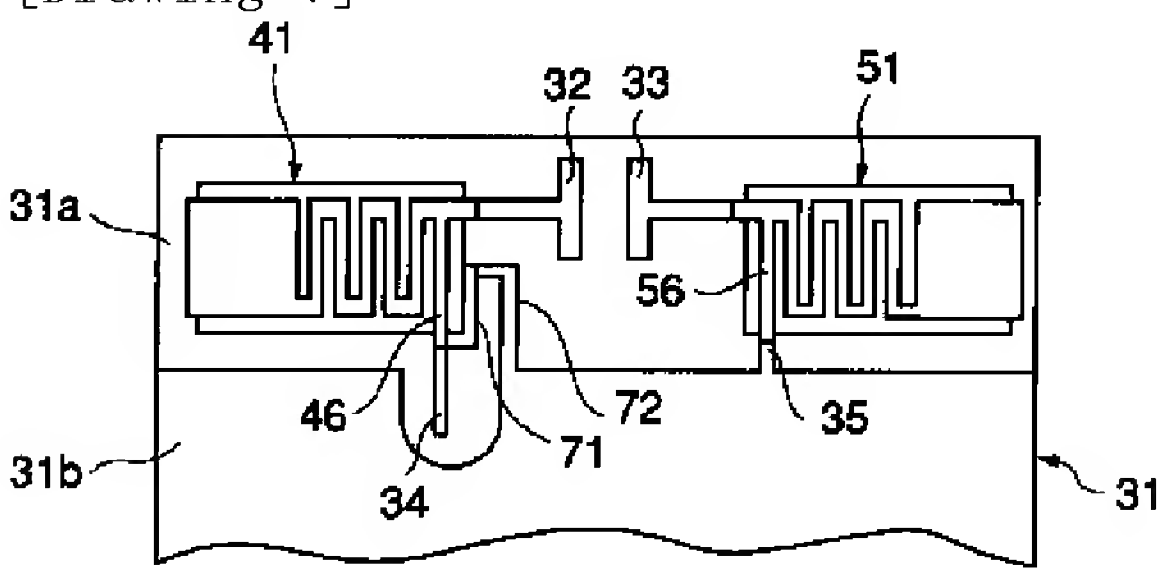
(B)



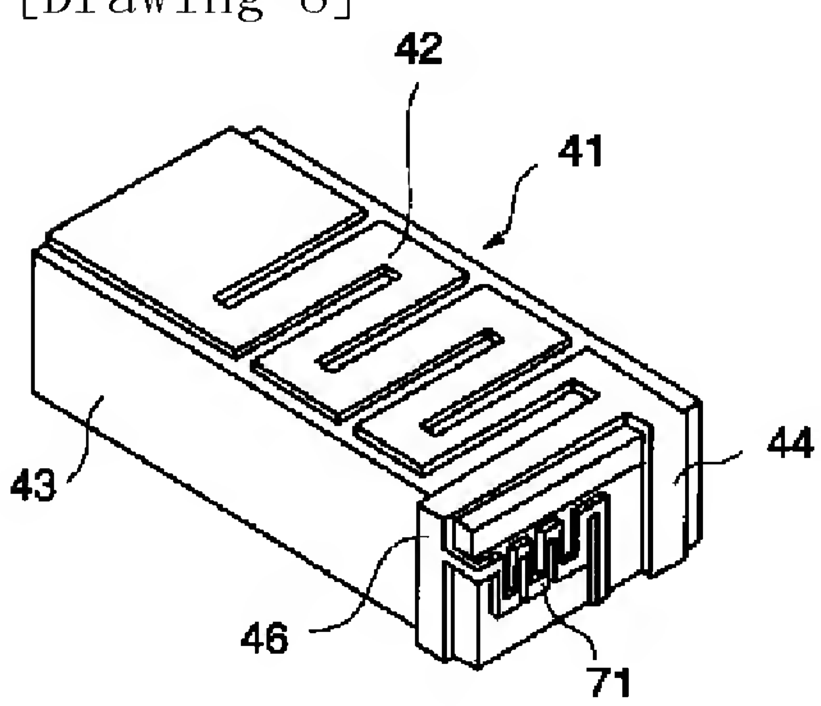
[Drawing 6]



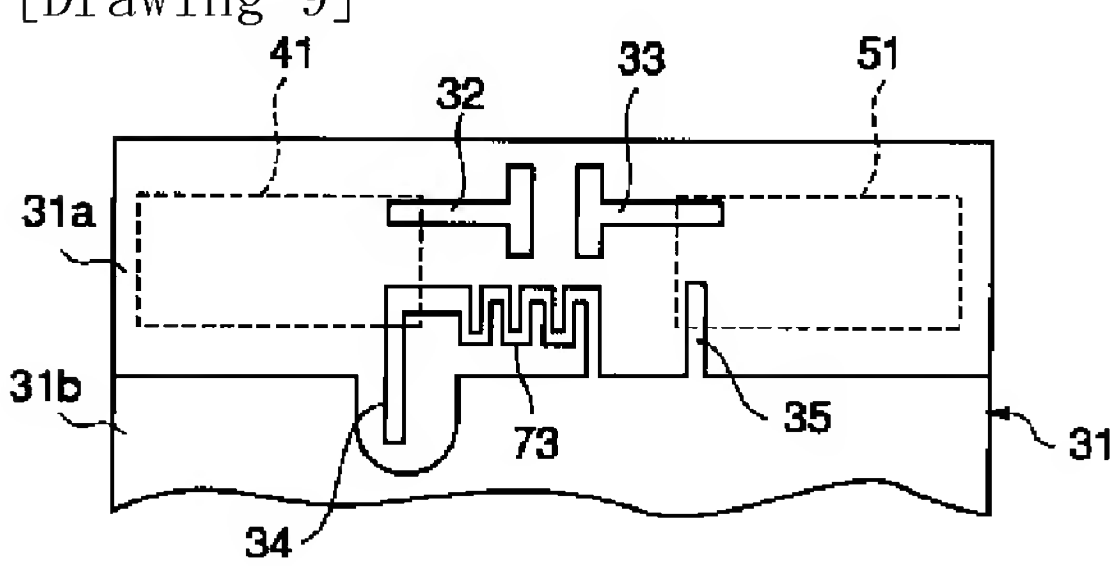
[Drawing 7]



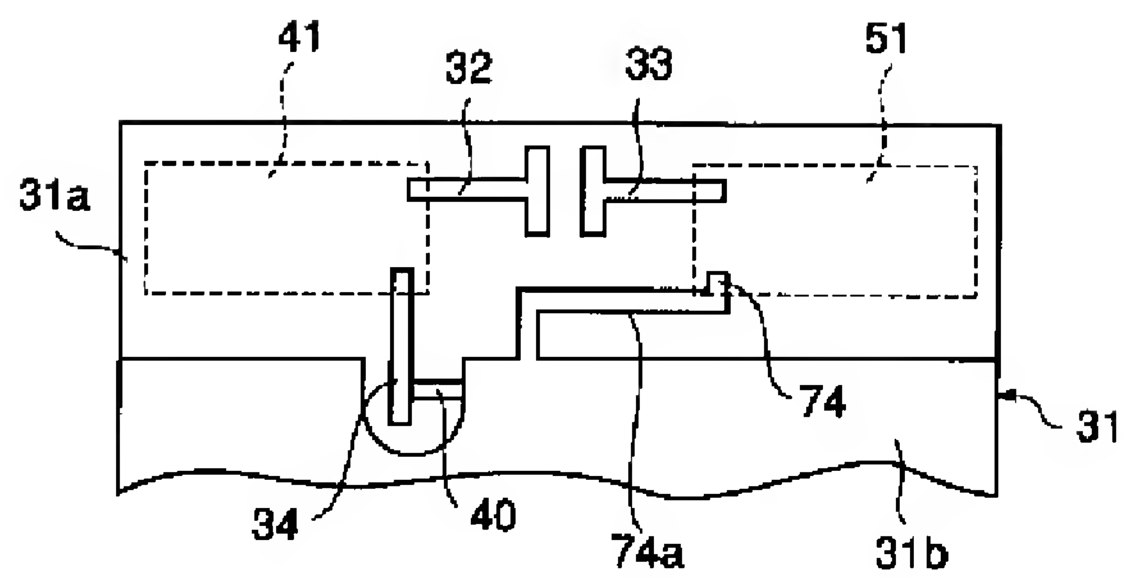
[Drawing 8]



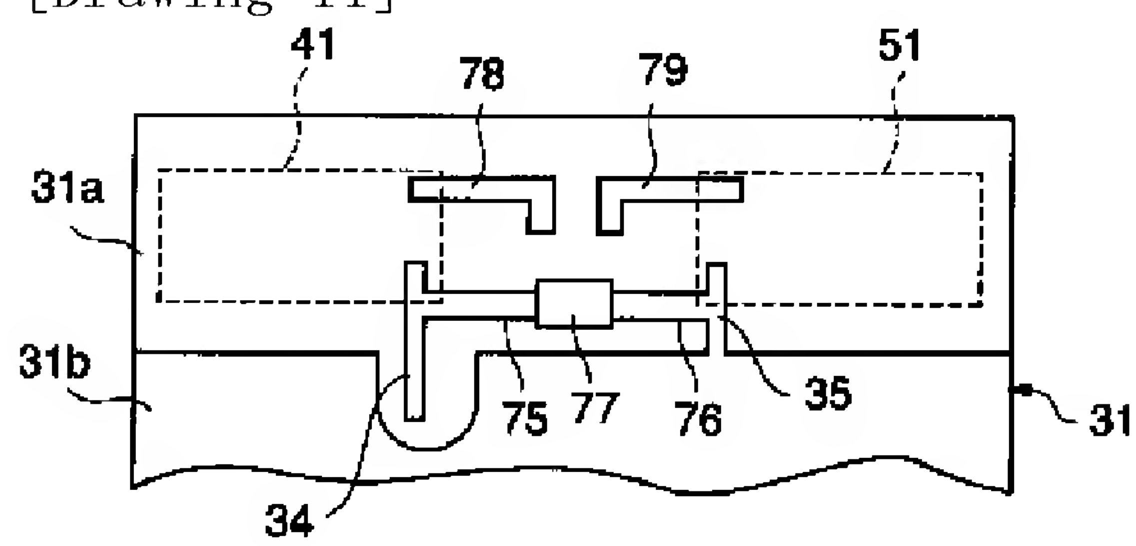
[Drawing 9]



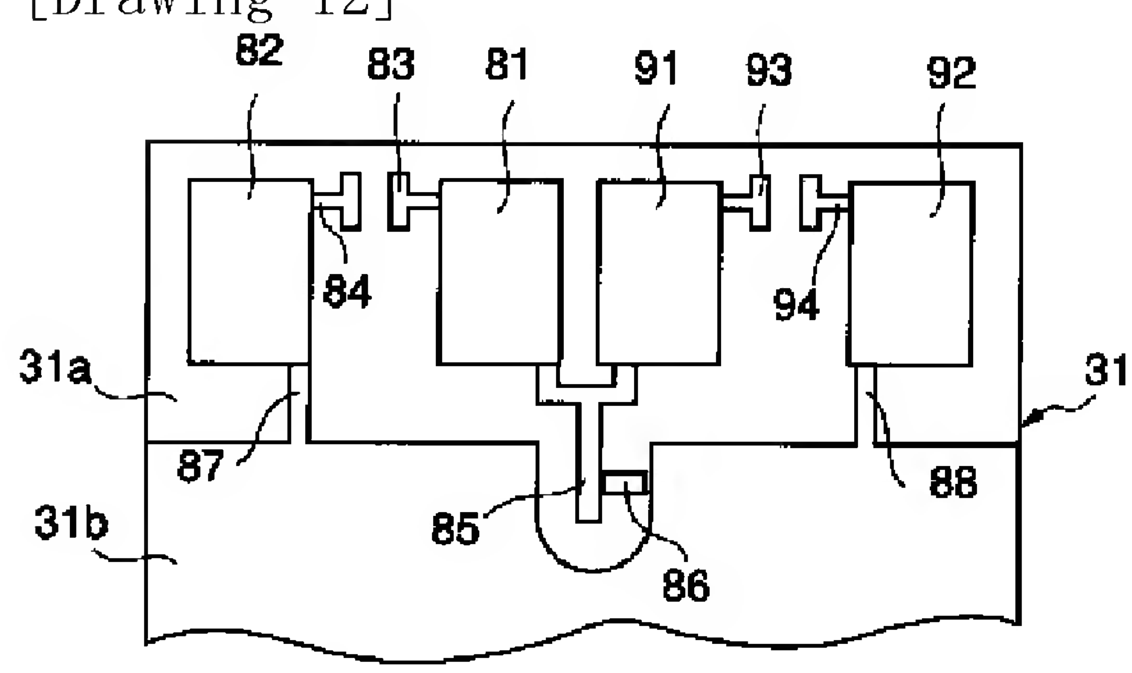
[Drawing 10]



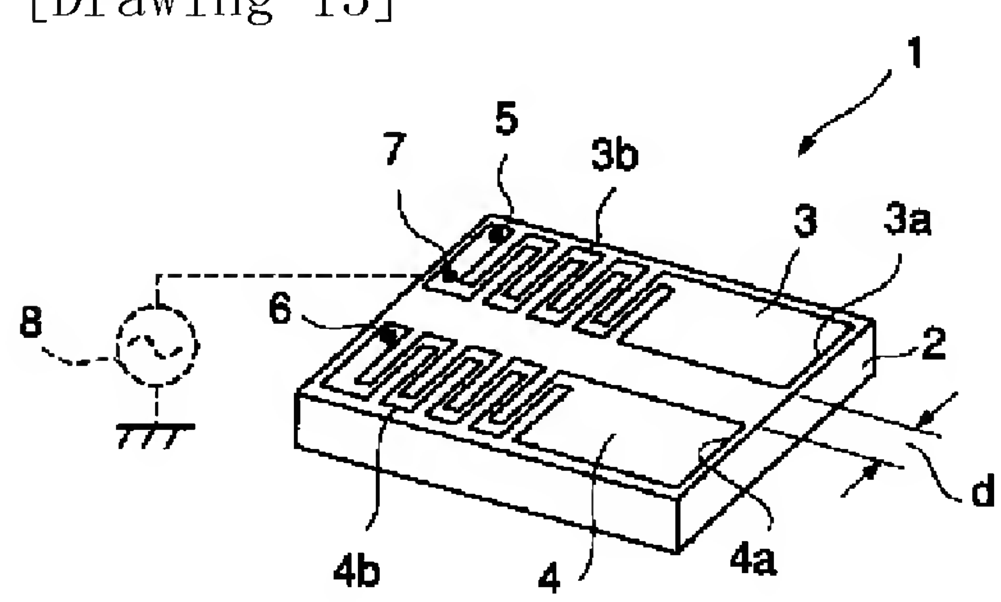
[Drawing 11]



[Drawing 12]



[Drawing 13]



[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公 開 特 許 公 報（Ａ）　(11)特許出願公開番号
特開2002−319811
（P2002−319811A）
(43)公開日　平成14年10月31日(2002.10.31)

(51)Int.Cl.7	識別記号	ＦＩ	テーマコード゛(参考)
Ｈ０１Ｑ　1/38		Ｈ０１Ｑ　1/38	５Ｊ０２１
5/01		5/01	５Ｊ０４５
13/08		13/08	５Ｊ０４６
21/30		21/30	

審査請求　未請求　請求項の数５　ＯＬ　（全 11 頁）

(21)出願番号　特願2001−121411(P2001−121411)

(22)出願日　平成13年４月19日(2001.4.19)

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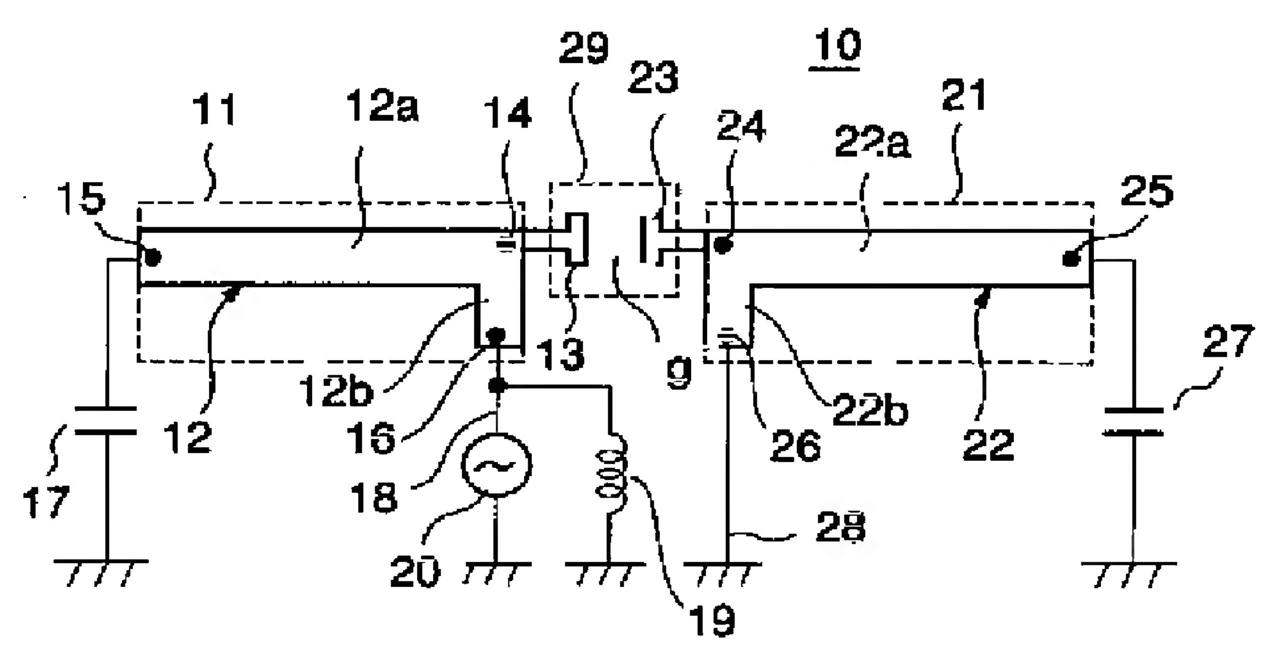
最終頁に続く

(54)【発明の名称】　複共振アンテナ

(57)【要約】
【課題】　複共振アンテナの電気的体積は誘電体の基体の大きさで決まるが、基体を大きくすると加工精度が悪くなり、電気的体積の大きな複共振アンテナを作製するのが困難であった。
【解決手段】　給電励振子１１及び無給電励振子２１を夫々個別に構成する。この給電励振子１１及び無給電励振子２１は、これらとは別に設けた電界結合手段１３，２３で電界結合する。この構成により、複共振アンテナ全体を１枚の誘電体の基体に構成する必要はなくなる。例えば、給電励振子１１及び無給電励振子２１毎に夫々誘電体の基体で構成し、通常の回路基板に電界結合手段１３，２３を形成し、回路基板上で給電励振子１１及び無給電励振子２１と電界結合手段１３，２３を接続すると、十分な大きさの電気的体積を持った複共振アンテナが得られる。



【特許請求の範囲】

【請求項１】　一端に給電端子を有する第１の放射電極の中間部に電界結合端子を接続してなる給電励振子と、一端に接地端子を有する第２の放射電極の中間部に電界結合端子を接続してなる無給電励振子と、前記給電励振子及び前記無給電励振子とは別に設けられて、前記給電励振子と前記無給電励振子の電界結合端子を電界により結合する電界結合手段と、前記給電励振子の給電端子に信号電流を流す給電回路と、前記無給電励振子の接地端子を接地する接地回路とから構成することを特徴とする複共振アンテナ。

【請求項２】　前記給電励振子及び前記無給電励振子は、放射電極を形成する誘電体の基体を個別に備え、前記電界結合手段は、回路基板に対向配置した一対の電界結合パターンで構成すると共に、前記給電励振子及び前記無給電励振子を前記回路基板上に載置して、前記給電励振子の電界結合端子を前記一方の電界結合パターンに接続し、前記無給電励振子の電界結合端子を前記他方の電界結合パターンに接続して構成したことを特徴とする請求項１に記載の複共振アンテナ。

【請求項３】　前記一対の電界結合パターンを近接配置して容量成分を付与したことを特徴とする請求項２に記載の複共振アンテナ。

【請求項４】　前記一対の電界結合パターン間にコンデンサを接続したことを特徴とする請求項２に記載の複共振アンテナ。

【請求項５】　前記給電励振子と前記無給電励振子の間には、前記給電回路のインピーダンスを整合すると共に前記給電回路と前記接地回路との間に流れる電流量を調整する整合兼用電流結合手段を備えたことを特徴とする請求項１乃至請求項４の何れか１つに記載の複共振アンテナ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、複数の周波数を使用する移動体通信機器などに用いる複共振アンテナに関するものである。

【０００２】

【従来の技術】近年、携帯電話機などの移動体通信機器では、交信チャンネルの混雑を解消するため、１台の携帯電話機で２つの周波数を切替て使用するものがあり、このような２つの周波数を使用するには、携帯電話機に搭載されるアンテナが２つの周波数の電波を送受信する機能を有することが要求される。このようなアンテナの事例には、特開平９－２６０９３４号公報に記載されている複共振アンテナが有る。このアンテナは、８１８ＭＨｚのディジタル信号周波数と８７３ＭＨｚのアナログ信号周波数との同調を取ることにより、２つの周波数帯域をカバーするものであり、図１３に示すように、異なる周波数で励振される２つの励振子を備えている。

【０００３】図１３に於いて、２つの周波数で励振する複共振アンテナ１は、１枚の誘電体で作られた基体２の上に、２つの放射電極３，４を間隔ｄを設けて平行に配設して構成されている。放射電極３，４は、一端側を板状の開放端３ａ，４ａとすると共に他端側をミアンダ形状に形成し、ミアンダ形状部３ｂ，４ｂの末端に接地部５，６を設け、この接地部５，６を接地している。また、放射電極３には、ミアンダ形状部３ｂの端部に給電部７を設け、この給電部７を信号源８に接続している。

【０００４】この構成により、信号源８から信号の供給を受ける放射電極３が給電励振子となり、信号を入力しない放射電極４が無給電励振子となる。放射電極４は、間隔ｄを介して放射電極３と電磁結合（主に電界結合）しており、給電励振子と無給電励振子を夫々異なる周波数で励振するものである。

【０００５】

【発明が解決しようとする課題】しかしながら、誘電体からなる１枚の基体２上に、２つの放射電極３，４を間隔ｄを介して併設するので、高周波特性の良い且つ表面積の大きな誘電材料が必要になると共に、アンテナの電気的体積は誘電体で作られた基体２の大きさにより決定される。従って、アンテナの特性を向上させるには基体２自身を大きくする必要があるが、大きな誘電体を精度良く加工するのが難しく、必要なアンテナの電気的体積を確保するのは困難である。

【０００６】特に、誘電材料として優れたセラミックス材料を用いた場合には、焼成時の収縮のため寸法公差が大きくなり、表面積の大きな基体を寸法精度良く作製するのが困難であることに加え、セラミックス材料は回路基板に用いる樹脂材料に比べて高価であるため、基体の価格が上昇し、アンテナを安価に製造することができなく、また、セラミックス材料は回路基板に用いる樹脂材料に比べて非常に重く、アンテナを軽量に構成することができず、ひいては、アンテナを組込んだ使用機器の軽量化に資することができない。

【０００７】本発明は上記課題を解決するために成されたものであり、その目的は、アンテナの電気的体積を確保し且つ複共振特性の良好なアンテナを提供することにある。

【０００８】

【課題を解決するための手段】上記目的を達成するために、この発明は次に示す構成をもって前記課題を解決する手段としている。即ち、第１の発明の複共振アンテナは、一端に給電端子を有する第１の放射電極の中間部に電界結合端子を接続してなる給電励振子と、一端に接地端子を有する第２の放射電極の中間部に電界結合端子を接続してなる無給電励振子と、給電励振子及び無給電励振子とは別に設けられて、給電励振子と無給電励振子の電界結合端子を電界により結合する電界結合手段と、給電励振子の給電端子に信号電流を流す給電回路と、無給

電励振子の接地端子を接地する接地回路とから構成することを特徴とするものである。
【0009】上述の構成に於いて、給電励振子は、給電回路を介して信号源から信号電力である共振エネルギーの供給を受けて使用する電波の周波数で共振すると共に、このエネルギーの一部は電界結合手段を介して無給電励振子に供給され、無給電励振子を複共振させる。ここで、複共振とは、給電励振子のリターンロスと無給電励振子のリターンロスが近接しつつも共存し合い、結果として、非常に広範な周波数帯に於いてマッチングの取れた状態をいう。
【0010】また、電界結合手段は、給電励振子及び無給電励振子とは別個に設けられており、両励振子間の結合容量を決定する。この結合容量を適切に設定することにより、給電励振子と無給電励振子の直接的な電界結合なしに、良好な複共振アンテナ特性が得られる。
【0011】第2の発明の複共振アンテナに於いては、上述の発明に於いて、給電励振子及び無給電励振子は、放射電極を形成する誘電体の基体を個別に備え、電界結合手段は、回路基板に対向配置した一対の電界結合パターンで構成すると共に、給電励振子及び無給電励振子を回路基板上に載置して、給電励振子の電界結合端子を一方の電界結合パターンに接続し、無給電励振子の電界結合端子を他方の電界結合パターンに接続して構成したことを特徴とするものである。
【0012】この発明に於いて、給電励振子及び無給電励振子は、夫々誘電体の基体を用いて構成されるので、放射電極を小さく形成でき、励振子自体が小型に構成される。この給電励振子及び無給電励振子は、樹脂材料を主体とした回路基板に載せて固定され、給電励振子と無給電励振子間の結合は、回路基板に形成した一対の電界結合パターンで行われる。
【0013】両電界結合パターンは、所定の間隔を介して配設されており、電界結合パターン間の容量成分により電界結合している。容量成分の大きさは、電界結合パターン間の対向する部分の間隔、対向部分の長さ、対向面積等により決まり、この容量成分の大きさを調整することにより給電励振子と無給電励振子間の電界結合の大きさが調整される。
【0014】第3の発明の複共振アンテナは、第2の発明の構成に於いて、一対の電界結合パターンを近接配設して容量成分を付与したことを特徴とするものである。
【0015】この構成によれば、電界結合パターン間の容量成分を最適な範囲に設定することにより、給電励振子と無給電励振子間の電界結合の強さが最適に定まり、給電励振子及び無給電励振子は調整された複共振の動作をする。
【0016】第4の発明の複共振アンテナは、第2の発明の構成に於いて、一対の電界結合パターン間にコンデンサを接続したことを特徴とするものである。
【0017】この発明では、電界結合パターン間の結合容量はコンデンサの容量値として決まるので、給電励振子と無給電励振子間の最適結合は、コンデンサの値を選択することにより容易に得られる。
【0018】第5の発明の複共振アンテナは、上述の何れかの発明に於いて、給電励振子と無給電励振子の間には、給電回路のインピーダンスを整合すると共に給電回路と接地回路との間に流れる電流量を調整する整合兼用電流結合手段を備えたことを特徴とするものである。
【0019】この発明に於いて、整合兼用電流結合手段は、信号源と給電励振子間のインピーダンスを整合しエネルギーの供給が効率良く行われるように構成すると共に、給電回路と接地回路の間を電流的に結合するものであり、給電励振子と無給電励振子の間に流れる電流量を調整する働きをする。また、給電回路と接地回路を流れる電流の電流量が大きいため、整合兼用電流結合手段は、電流結合に加えて、磁界結合によっても無給電励振子に流れる電流量を調整する構成とすることができる。
【0020】上述の構成に於いて、整合兼用電流結合手段は、インダクタンス成分を有するインダクタンス回路として構成することができる。インダクタンス成分は、インダクタンス値を適宜に設定することにより、給電回路に対するインピーダンスとなるので、確実に複共振アンテナのインピーダンスが整合される。また、インダクタンス回路が一定の長さの回路配線を有する場合には、この回路配線は磁界を発生するので、磁界結合により接地回路に流れる電流量を調整することが可能となる。
【0021】また、整合兼用電流結合手段に接地回路の一部を給電回路に近接させた構成を含めることができる。この構成の採用により、接地回路と給電回路が強く磁界結合し、接地回路に流れる電流量が調整される。
【0022】
【発明の実施の形態】以下に、本発明に係る実施形態例を図面に基いて説明する。図1は、本発明に係る複共振アンテナの基本構成を示す。給電励振子１１及び無給電励振子２１は、夫々、ストリップ状の放射電極１２，２２で構成されている。この放射電極１２，２２は、導電体を用いて長片１２ａ，２２ａと短片１２ｂ，２２ｂから形成されており、放射電極１２，２２の全長（長片１２ａ，２２ａと短片１２ｂ，２２ｂの和の長さ）Ｌは、使用する電波に於ける周波数の波長をλ、放射電極１２，２２を設けた部分の比誘電率をεとすると、ほぼ、$L=n\cdot\lambda/4\cdot\sqrt{\varepsilon}$　となっている。但し、ｎは自然数である。
【0023】給電励振子１１と無給電励振子２１の間には、電界結合手段２９が形成されている。この電界結合手段２９は、例えば、一定の間隔ｇを介して対向する一対の導電体の電界結合パターン１３，２３から構成される。一方の電界結合パターン１３は、放射電極１２に設けた給電励振子１１の電界結合端子１４と接続されてお

り、また、他方の電界結合パターン２３は、放射電極２２に設けた無給電励振子２１の電界結合端子２４と接続されている。給電励振子１１及び無給電励振子２１は、一対の電界結合パターン１３，２３を介して電界結合する。

【００２４】給電励振子１１及び無給電励振子２１には，放射電極１２，２２の長片１２ａ，２２ａに於ける開放端部１５，２５とグランドの間に、夫々コンデンサ１７，２７が接続されている。このコンデンサ１７，２７は、通常、放射電極１２，２２とグランド間に形成される浮遊容量として与えられる。また、給電励振子１１の給電端子１６は、放射電極１２の短片１２ｂの開放端側に設けられ、給電回路１８の信号源２０に接続されると共に、インダクタ１９を介して接地されている。一方、無給電励振子２１の接地端子２６は、放射電極２２の短片２２ｂの開放端側に設けられ、接地回路２８を介して接地されている。

【００２５】この構成に於いて、給電励振子１１が信号源２０から送信信号電力の投入を受けると、放射電極１２に高周波の共振電流が流れ、また、無給電励振子２１の放射電極２２にも電界結合パターン１３，２３を介して信号電力が供給され、放射電極２２に高周波の共振電流が流れる。給電励振子１１から放射される電波の周波数ｆ１は、無給電励振子２１から放射される電波の周波数ｆ２と異なり、通常、周波数ｆ１は周波数ｆ２よりも大きくなる。一対の電界結合パターン１３，２３は、給電励振子１１と無給電励振子２１間を電界結合しており、この電界結合パターン１３，２３の構成を変えることにより電界結合量を変化させ、アンテナの複共振特性を調整する。

【００２６】また、コンデンサ１７，２７は、給電励振子１１及び無給電励振子２１に於いて共振周波数ｆ１、ｆ２を決める共振回路要素となっており、コンデンサ１７，２７の容量値を変えることにより共振周波数が変化する。そして、インダクタ１９は、信号源２０に対しアンテナのインピーダンスを整合させる働きをし、同時に、グランドを介して無給電励振子２１の接地端子２６と結合して、給電励振子１１の給電端子１２ｂと無給電励振子２１の接地端子２６間を流れる高周波電流量を調整する機能を有している。

【００２７】従って、上述の複共振アンテナによれば、給電励振子１１及び無給電励振子２１の構成を変更することなく、電界結合パターン１３，２３を適切に構成することにより最適な複共振特性とすることができる。

【００２８】上記複共振アンテナの基本構成の等価回路を図２に示す。図２に於いて、共振インダクタンスＬ１と放射抵抗Ｒ１は放射電極１２を現しており、共振インダクタンスＬ２と放射抵抗Ｒ２は放射電極２２を現している。また、装荷容量Ｃ１は、給電励振子１１に接続されたコンデンサ１７を現し、装荷容量Ｃ２は、無給電励振子２１に接続されたコンデンサ２７を現している。

【００２９】これら共振インダクタンスＬ１、放射抵抗Ｒ１及び装荷容量Ｃ１は、給電励振子１１の共振回路を形成しており、同様に、共振インダクタンスＬ２、放射抵抗Ｒ２及び装荷容量Ｃ２は、無給電励振子２１の共振回路を形成している。２つの共振回路間の結合容量Ｃ１２は、一対の電界結合パターン１３，２３を現し、給電励振子１１と無給電励振子２１間の電界結合は、等価的には容量結合である。また、結合インダクタンスＬ１２は、インダクタ１９を現しており、２つの共振回路間を流れる電流量を調整する。

【００３０】この等価回路から明らかなように、２つの共振回路の共振周波数ｆ1，ｆ２を維持しながら良好な複共振を実現するためには、装荷容量Ｃ１，Ｃ２及び結合容量Ｃ１２の容量値を整合させる必要がある。結合容量Ｃ１２は、一対の電界結合パターン１３，２３の間隔ｇ、対向面積及び対向部分の長さを適切に設定することにより、装荷容量Ｃ１，Ｃ２とバランスの取れた結合容量Ｃ１２とすることが可能である。例えば、樹脂材料を主体とする回路基板に形成した電界結合パターン１３，２３の場合には、間隔ｇ、対向面積及び対向部分の長さの微調整は、トリミング装置で行うことができる。

【００３１】また、装荷容量Ｃ１，Ｃ2は、主に、給電励振子１１及び無給電励振子２１の構成できまり、給電励振子１１及び無給電励振子２１に於ける放射電極１２，２２とグランド間の浮遊容量を集中定数として現している。

【００３２】上述の等価回路に於いて、結合容量Ｃ１２を大きくすると、換言すれば、電界結合パターン１３，２３間の静電容量を大きくすると、給電励振子１１と無給電励振子２１間の電界結合が強くなり、共振周波数ｆ1と共振周波数ｆ２が分離せず、給電励振子１１と無給電励振子２１は、恰も１つの励振子の如く動作し、また、そのリターンロスは浅くなる。これとは逆に、結合容量Ｃ１２が小さくなると、換言すれば、電界結合パターン１３，２３間の静電容量を小さくすると、給電励振子１１と無給電励振子２１間の電界結合が弱くなり、給電励振子１１と無給電励振子２１は、夫々独立した動作を強め、複共振の周波数特性が得られなくなる。

【００３３】また、装荷容量Ｃ１，Ｃ２を大きくすると、相対的に結合容量Ｃ１２が小さくなり、換言すれば、電界結合パターン１３，２３に於ける電界結合が弱くなり、上述の如く、共振周波数ｆ１，ｆ２による複共振が得られなくなる。逆に、装荷容量Ｃ１，Ｃ２を小さくすると、相対的に結合容量Ｃ１２が大きくなり、等価回路の容量バランスが崩れたものとなる。換言すれば、結合容量Ｃ１２の増大は、電界結合パターン１３，２３に於ける電界結合の増大となって、上述の如く、給電励振子１１及び無給電励振子２１の共振周波数ｆ１，ｆ２が接近して複共振とならなくなる。

【００３４】図３は、本発明の複共振アンテナに係る具体的な実施形態例を示す。図３に於いて、複共振アンテナ３０は、樹脂材料を主体として作られた回路基板３１に２つのアンテナチップ４１，５１を載置して構成される。回路基板３１は、表面にアンテナ形成部３１ａとグランド部３１ｂが設けられており、裏面には図示しない回路配線が形成されている。グランド部３１ｂには、絶縁基板の上に銅箔などを貼付して形成したグランド層が設けられている。回路基板３１のアンテナ形成部３１ａには、略Ｔ字形の一対の電界結合パターン３２，３３がＴ字形状部分を一定の間隔ｇを介して対向し、導電体によりパターン形成されている。

【００３５】また、アンテナ形成部３１ａには、給電回路となる給電パターン３４及び接地回路となる接地パターン３５がパターン形成されている。給電パターン３４は、グランド部３１ｂのグランド層から電気絶縁されて形成され、グランド部３１ｂにはチップインダクタ４０を介して接続されている。この給電パターン３４は、図示しない信号配線に接続されている。また、接地パターン３５は、グランド部３１ｂのグランド層に接続されている。

【００３６】上述した電界結合パターン３２，３３、給電パターン３４及び接地パターン３５は、グランド部３１ｂのグランド層と同じ導電体であり、エッチング等の周知の方法により一度にパターン形成される。

【００３７】アンテナチップ４１，５１は、誘電体の基体４３，５３の表面に放射電極４２，５２を備えている。放射電極４２と放射電極５２の対向する側の端部（対向端部）には、帯状の電界結合端子４４，５４が設けられている。この電界結合端子４４，５４は、夫々基体４３，５３の側面を垂下し先端が基体４３，５３の裏面側に回り込んで形成されている。そして、一方の電界結合端子４４は、電界結合パターン３２のＴ字形状部分と反対側の端部に接続され、他方の電界結合端子５４は、電界結合パターン３３のＴ字形状部分と反対側の端部に接続されている。

【００３８】また、放射電極４２の対向端部には、帯状の給電端子４６が設けられ、この給電端子４６は、基体４３の表面を電界結合端子４４に対して直角の方向に伸張し且つ基体４３の側面を降下して基体４３の裏面側に回り込んで形成されている。この給電端子４６は、回路基板３１の表面に設けた給電パターン３４の一端に接続されている。放射電極５２の対向端部には、帯状の接地端子５６が設けられており、この接地端子５６は、基体５３の表面を電界結合端子５４に対して直角の方向に伸張して設けられ且つ基体５３の側面を降下して基体５３の裏面側に回り込んで形成され、接地パターン３５に接続されている。

【００３９】更に、放射電極４２，５２の開放端部４７，５７は、電界結合端子４４，５４の反対側に於いて、夫々基体４３，５３の側面の途中まで垂下して形成されている。そして、この開放端部４７，５７を設けた同じ側面には、これら開放端部４７，５７に対し一定の間隔を介して固定端子４８，５８が形成されている。固定端子４８，５８は、基体４３，５３の裏面まで伸張して設けられており、回路基板３１に形成した固定パターン３６，３７に接続されている。

【００４０】上述の具体的な実施形態例に於いて、給電パターン３４は、図示しない送信回路及び受信回路に接続されており、放射電極４２，５２から送受信される高周波電流の通路となる。例えば、送信信号電流は、給電端子４６から放射電極４２に流入し、共振電流を励起すると共に、電界結合端子４４から電界結合パターン３２，３３を通って電界結合端子５４に供給され、放射電極５２の共振回路を励振する。このとき、接地端子５６にはグランドに向け高周波電流が流れる。

【００４１】給電励振子４１と無給電励振子５１は、電界結合パターン３２，３３で電界結合しており、電界結合量を変えることにより、給電励振子４１と無給電励振子５１との間の結合を調整し、良好な複共振マッチングを得ることができる。電界結合パターン３２，３３の等価容量は、電界結合パターン３２，３３間の間隔ｇ及び対向部分の長さで決まる。

【００４２】また、放射電極４２，５２の開放端部４７，５７と固定端子４８，５８の間には、夫々開放端容量が形成されており、放射電極４２，５２に於ける共振回路の回路素子として働き、放射電極４２，５２に流れる共振電流の周波数を決める要素となる。

【００４３】更に、給電パターン３４とグランド部３１ｂとの間に接続されたチップインダクタ４０は、給電配線のインピーダンス、例えば、５０Ωに対しアンテナのインピーダンスを整合させるものであり、これにより、アンテナと信号源２０間のインピーダンスの整合が得られ、損失なく信号の送受信ができる。また、チップインダクタ４０は、グランド部３１ｂを介して接地パターン３５と電気的に結合しており、給電励振子４１と無給電励振子５１間を流れる高周波電流の通路となっている。ここに、チップインダクタ４０は、給電励振子４１と無給電励振子５１間の電流回路のインピーダンスとなり、給電励振子４１と無給電励振子５１間の電流結合量を決定している。

【００４４】上述したように、電界結合パターン３２，３３間の構成を変えることにより、給電励振子４１と無給電励振子５１間の電界結合量を決定し、アンテナの複共振特性を調整することができる。また、チップインダクタ４０のインダクタンス値を選ぶことにより、給電ラインに対するアンテナのインピーダンスを整合すると共に給電励振子４１と無給電励振子５１間の電流結合量を調整することができる。

【００４５】なお、上述の実施形態例では、給電励振子

４１と無給電励振子５１の放射電極４２，５２は、面対称の形状に形成したので、例えば、放射電極４２，５２をスクリーン印刷などで形成する際に、無給電励振子５１の放射電極５２には、給電励振子４１の放射電極４２で利用したマスクの反転パターンを使用できるので、チップアンテナ４１，５１の製造コストを引下げることができる。

【００４６】また、上述の実施形態例では、回路基板３１のアンテナ形成部３１ａには、電界結合パターン３２，３３、給電パターン３４、接地パターン３５及び固定パターン３６，３７のみが設けられ、グランド層は存在しないが、固定パターン３６，３７を伸ばしてグランド部３１ｂのグランド層に接続しても良い。これらはアンテナ複共振特性を考慮して決められる。

【００４７】更に、上述の実施形態例では、チップアンテナ４１，５１は、その長手方向を直線状に配列しているが、その配列は設計のとき自由に定めることができる。例えば、チップアンテナ４１，５１は、長手方向が平行となるように配置したり、チップアンテナ４１，５１の長手方向が一方を他方に対して直角状に配列したり、また、チップアンテナ４１，５１を相互に傾けて、例えば、ハの字に配置しても良い。

【００４８】このようなチップアンテナ４１，５１の自由な配置は、電界結合パターン３２，３３を回路基板３１に設け、この電界結合パターン３２，３３を利用して２つのチップアンテナ４１，５１を電界結合する構成により初めて実現可能となるものであり、これにより、無線機器の筐体に合わせたチップアンテナ４１，５１の配置が可能となるので、複共振アンテナ設計の自由度が増大する。

【００４９】更にまた、上述の実施形態例では、チップアンテナ４１，５１は、複共振状態に於いて、独自の共振周波数ｆ１、ｆ２を持っているので、チップアンテナ４１，５１は、寸法が相互に相違していても良く、また、基体４３，５３の比誘電率も相互に相違させることができ、基体４３，５３の形状も放射電極４２，５２の形成表面が長方形のみならず、正方形であっても良い。

【００５０】更にまた、上述の実施形態例では、２つのチップアンテナ４１，５１は、放射電極４２，５２の形状を面対称としたが、これは非対称であっても良く、例えば、一方の放射電極を板状に形成し、他方の放射電極をミアンダ形状に形成しても良い。また、２つのチップアンテナ４１，５１の放射電極４２，５２をミアンダ形状に形成するときには、つづら折れ状の放射電極を、一方は基体表面の長手方向に伸張し、他方は基体表面の短手方向に伸張する構成とすることができ、また、一方をつづら折れ状の放射電極とし、他方を渦巻き状の放射電極とするなど、自由に設計することができる。従って、２つのチップアンテナ４１，５１の放射電極４２，５２を形成する際にも設計の自由度が大きくなる。

【００５１】上記何れの実施形態例の場合でも、回路基板を利用することにより、給電励振子及び無給電励振子は小さく構成しても、複共振アンテナとしての領域を広く取れるので、アンテナの電気的体積が増大し、周波数帯域幅の広い高利得の複共振アンテナを安価に製造することができる。

【００５２】図４乃至図６に示す実施形態例は、給電励振子と無給電励振子を電気的に結合する他の構成を示すもので、図３の実施形態例と同一構成部分には同一符号を付し、その共通部分の重複説明は省略する。

【００５３】図４に於いて、給電励振子４１を接続する電界結合パターン６１は、回路基板３１に於けるアンテナ形成部３１ａの表面に形成され、無給電励振子５１を接続する電界結合パターン６２は、回路基板３１の裏面に形成されている。電界結合パターン６１，６２の先端部分は、回路基板３１を介して上下に重なっており、電界結合パターン６１，６２間には、回路基板３１の厚みと対向面積に応じた結合容量が発生し、給電励振子４１と無給電励振子５１間を容量結合する。

【００５４】この結合容量は、電界結合パターン６１，６２の対向面積を変えることにより変更することができる。また、無給電励振子５１の電界結合端子５４は、回路基板３１の表面側に設けた中継パターン６３に接続され、この中継パターン６３は、スルーホール６４を通して電界結合パターン６２に接続される。

【００５５】図５に示す実施形態例は、無給電励振子５１を回路基板３１の裏面側に配置した点で図４の実施形態例と相違する。無給電励振子５１の電界結合端子は、図３と同様に、直接電界結合パターン６２に接続されている。回路基板３１の裏面には固定パターン６６が設けられ、この固定パターン６６に無給電励振子５１の固定端子５８が接続されている。この構成により、回路基板３１に於けるアンテナ形成部３１ａの表裏面の空間が有効に利用される。

【００５６】また、図６の実施形態例は、電界結合手段２９として、２つの電界結合パターン６８，６９を結合容量が形成される間隔を介して配置する代りに、２つの電界結合パターン６８，６９がコンデンサ７０で結合されている。コンデンサ７０には、チップコンデンサが使用される。この構成により、給電励振子４１と無給電励振子５１間は、コンデンサ７０で結合され、コンデンサ７０の容量値を変えることにより、給電励振子４１と無給電励振子５１間の結合度を変えることができる。

【００５７】図７乃至図１１に示す実施形態例は、信号源に対し複共振アンテナのインピーダンスを整合すると共に給電励振子と無給電励振子との間の電流結合量を調整する他の構成を示すもので、図３の実施形態例と同一構成部分には同一符号を付し、その共通部分の重複説明は省略する。

【００５８】図７及び図８に於いて、給電励振子４１の

基体４３の側面には、図３のチップインダクタ４０を用いたインダクタンス回路に代えて、一端を給電端子４６に接続した電極パターン７１が形成されている。この電極パターン７１の他端は、回路基板３１のアンテナ形成部３１ａに形成した連結パターン７２を介してグランド部３１ｂのグランド層に接続されている。電極パターン７１は、ミアンダ形状に形成されてインダクタンス成分が付与される。

【００５９】この構成に於いて、図３のチップインダクタ４０と同様に、電極パターン７１のインダクタンス値により、信号源に対し複共振アンテナのインピーダンスが整合される。また、連結パターン７２は、グランド部３１ｂを介して接地パターン３５と電気的に結合しており、給電励振子４１と無給電励振子５１間は、電極パターン７１のインピーダンスを介して電流結合し、給電励振子４１と無給電励振子５１間を流れる電流量が調整される。この場合、連結パターン７２と接地パターン３５が近接して設けられたときには、磁界結合によっても接地パターン３５を流れる電流量を決めることができる。

【００６０】上述の構成によれば、電極パターン７１は、給電励振子４１に於ける基体４３の表面に形成されるから、給電励振子４１を作製するとき、放射電極４２の形成と同じ製造方法で形成することができ、また、連結パターン７２は、給電パターン３４及び接地パターン３５の形成と同時に回路基板３１に形成することができる。

【００６１】図９の実施形態例は、インダクタンス成分を有するパターンをアンテナチップ４１の基体４３に設ける代りに回路基板３１に設けた点で図７の実施形態例と相違している。なお、発明の構成を明確に示すため、チップアンテナ４１，５１を点線で示している。回路基板３１のアンテナ形成部３１ａの表面には、インダクタンス回路として給電パターン３４に連結したミアンダ形状のインダクタンスパターン７３が形成されている。

【００６２】インダクタンスパターン７３のインダクタンス値は、複共振アンテナからの送受信信号電力が最大となる値に設定される。また、インダクタンスパターン７３は、接地パターン３５の近くでグランド部３１ｂのグランド層に接続されており、インダクタンスパターン７３と接地パターン３５は、電流結合と共に磁界結合をする。

【００６３】即ち、インダクタンスパターン７３及び接地パターン３５を流れる電流量が大きいので、これらのパターン３５，７３から発生する磁界強度が大きくなる。この場合にも、インダクタンスパターン７３は、上述同様に、インピーダンスを整合すると共に、２つのチップアンテナ４１，５１間の電流結合量を決める他、磁界結合量によっても２つのチップアンテナ４１，５１間を流れる電流量を調整する。

【００６４】図１０実施形態例は、図３に示す実施形態例に、チップアンテナ４１，５１間に磁界結合の手段を付与したものである。なお、チップアンテナ４１，５１を点線で示している。チップアンテナ５１の接地端子５６を接続する接地パターン７４には、湾曲部７４ａが設けられ、給電パターン３４に接近してグランド部３１ｂのグランド層に接続されている。

【００６５】この構成によれば、給電パターン３４に流れる電流量が多いことから、上述したチップインダクタ４０による整合機能に加えて、給電パターン３４と接地パターン７４には磁界結合が生じ、チップアンテナ４１，５１間を流れる電流量を調整することができる。また、湾曲部７４ａの形態を変えることにより、接地パターン７４と給電パターン３４間の結合度合いを変えることができる。

【００６６】また、図１１は、２つのチップアンテナ４１，５１間にインダクタを設けて直接電流結合した実施形態例である。なお、チップアンテナ４１，５１を点線で示している。回路基板３１に形成した給電パターン３４には、給電引出パターン７５を連設し、接地パターン３５からは接地引出パターン７６を引出して、この給電引出パターン７５と接地引出パターン７６の間にインダクタ７７が接続されている。また、チップアンテナ４１，５１間を電界結合する電界結合パターン７８，７９は、略Ｌ字形に構成して対向している。

【００６７】この構成では、インダクタ７７により、信号源に対する複共振アンテナのインピーダンス整合と２つのチップアンテナ４１，５１間を流れる電流量を、インダクタ７７のインダクタンス値を選定することにより、直接的に調整することができ、複共振アンテナの設計が容易になる。また、電界結合パターン７８，７９による電界結合は、図３に示す実施形態例の略Ｔ字形の電界結合パターン３２，３３に比べて弱くなるが、電界結合パターン７８，７９の形状は、インダクタ７７による直接的な電流結合との整合を考慮して決められる。

【００６８】上述の構成の採用により、給電パターン３４と接地パターン３５は、インダクタ７７を介して直接的に電流結合する。インダクタ７７は、そのインダクタンス値により、複共振アンテナと信号源の間のインピーダンスを整合すると共に、給電パターン３４と接地パターン３５の間を流れる電流量を決定する。

【００６９】図１２実施形態例は、１つの回路基板上に、図３に示した実施形態例の複共振アンテナを２つ併設した２連式複共振アンテナの構成を示す。チップアンテナ８１，８２は、複共振を生じる対のチップアンテナであり、チップアンテナ９１，９２も複共振を生じる対となるチップアンテナである。チップアンテナ８１，８２は、電界結合パターン８３，８４を介して電界結合されており、チップアンテナ９１，９２も電界結合パターン９３，９４を介して電界結合されている。

【００７０】チップアンテナ８１，９１は、共通給電パ

ターン８５に接続されて、信号源から同時に信号電力が投入される。共通給電パターン８５とグランド部３１ｂのグランド層間にはインダクタ８６が接続されており、信号源に対して２つの複共振アンテナのインピーダンスを整合している。また、２つのチップアンテナ８２，９２は、接地パターン８７，８８を介して夫々グランド部３１ｂのグランド層に接続されている。

【００７１】この構成に於いて、チップアンテナ８１，８２による複共振とチップアンテナ９１，９２による複共振の周波数帯は離して設定される。例えば、チップアンテナ８１，８２が８００～９００ＭＨｚの周波数帯で複共振する場合には、チップアンテナ９１，９２は１７００～２１００ＭＨｚ帯で複共振するように設定される。換言すれば、相互に干渉を生じない程度に離れた周波数帯に於ける複数の複共振アンテナを共通の回路基板を用いて設計することができる。

【００７２】

【発明の効果】請求項１の複共振アンテナによれば、給電励振子及び無給電励振子とは別に両励振子間を結合する電界結合手段を設けたので、両励振子間の電界結合を最適化することにより、反射損失に於ける周波数特性の優れた複共振アンテナを得ることができる。そして、電界結合手段の構成を適宜に設定することにより、アンテナ全体の寸法の拡大に柔軟に対応することができ、給電励振子及び無給電励振子の構成を変えることなくアンテナの電気的体積を増大することができる。

【００７３】また、電界結合手段は、給電励振子及び無給電励振子から独立して形成されるため、アンテナの設計の自由度が増し、大電力送受信の用途に十分耐え得るアンテナを提供することができる。更に、給電励振子、無給電励振子及び電界結合手段を含んだ空間をアンテナ全体の電気的体積として利用できるので、広帯域且つ高利得のアンテナを実現することができる。

【００７４】請求項２の複共振アンテナによれば、給電励振子及び無給電励振子から独立して一対の電界結合パターンを設けたので、電界結合パターン間の容量を調整することにより給電励振子と無給電励振子間の電界結合量を調整することができる。

【００７５】従来に於いては、給電励振子と無給電励振子の構成を変更することにより両励振子間の電磁結合を調整しているが、この発明では、回路基板に形成された一対の電界結合パターン間の容量結合により給電励振子と無給電励振子間の電界結合量を調整するので、給電励振子及び無給電励振子の配置形態を自由に選択できると共に、励振子を構成する基体の形状、寸法及び誘電率も相互に同じでも異なっていても良く、放射電極の形状及び配置方向も何ら制限を受けない。

【００７６】従って、複共振アンテナの周波数及び周波数差の調整は、電界結合パターンで行うことが可能であるから、複共振アンテナ設計の自由度が増し、複共振アンテナの設計が容易になる。特に、電界結合の度合いを回路基板上に形成した電界結合パターンで行うので、大電力で電波を送受信する用途の複共振アンテナを作製することができる。

【００７７】また、給電励振子と無給電励振子の部分にのみ誘電体の基体が使用され、給電励振子と無給電励振子を電界結合する電界結合パターンは回路基板上に構成したから、従来のように、複共振アンテナ全体が誘電体の基体で構成されるアンテナとは異なり、複共振アンテナの寸法を柔軟に変更した設計をすることができる。

【００７８】特に、複共振アンテナの誘電体をセラミックス材料で構成した場合には、給電励振子と無給電励振子の部分にのみセラミックス材料の基体が使用され、複共振アンテナ全体に誘電体として大きな寸法のセラミックス材料の基体を用いる必要がないので、給電励振子と無給電励振子を加工精度良く作製し、また、複共振アンテナを安価に且つ軽量に作ることができる。

【００７９】更に、給電励振子及び無給電励振子の個々の配置に自由度があるので、複共振アンテナが組込まれる移動体通信機器の筐体に合せて柔軟に給電励振子及び無給電励振子の配置を決定することができる。このような場合でも、給電励振子、無給電励振子及び電界結合パターンを含んだ領域全体を複共振アンテナの電気的体積として利用するので、周波数帯域幅の広い高利得の複共振アンテナを実現することができる。

【００８０】請求項３の複共振アンテナによれば、電界結合パターンは、給電励振子及び無給電励振子から独立して回路基板に設けられるため、給電励振子及び無給電励振子の構成を考慮することなく種々のパターン構成とすることができ、複共振に於ける給電励振子と無給電励振子の共振周波数の設定及び給電励振子と無給電励振子間の周波数差の調整が容易となる。

【００８１】請求項４の複共振アンテナによれば、電界結合パターン間をコンデンサで結合するので、コンデンサの値を選択することにより最適な複共振アンテナとすることができる。

【００８２】請求項５の複共振アンテナによれば、整合兼用電流結合手段を給電励振子と無給電励振子の間に設けたので、信号源とのインピーダンス整合が容易であり、また、給電励振子と無給電励振子間を電流結合及び磁界結合させることができ、給電励振子及び無給電励振子の配置関係を考慮することなく、アンテナの電気的体積を増加する場合にも柔軟な設計が可能になる。

【００８３】また、整合兼用電流結合手段は、給電励振子及び無給電励振子とは別個に設計することができるので、給電励振子及び無給電励振子の形状を変形することなく複共振アンテナの寸法を自由に設定し、大電力送信の用途に適した複共振アンテナを得ることができる。

【００８４】更に、整合兼用電流結合手段をインダクタンス回路で構成したときには、このインダクタンス回路

のインピーダンスにより、給電回路に対する複共振アンテナのインピーダンスを整合させることができると共に、インダクタンス回路と接地回路間に流れる電流量が大きくても確実に電流量を調整することができる。また、インダクタンス回路の回路配線を接地回路に近接して配設することにより、磁界結合によっても接地回路に流れる電流量を調整することができる。

【0085】更にまた、整合兼用電流結合手段が、接地回路の一部を給電回路に近接させた構成を含むときには、磁界結合により接地回路に流れる電流量を調節することができると共に、整合兼用電流結合手段を調整することにより、接地回路と給電回路間の結合度合いを変えることができる。

【図面の簡単な説明】

【図１】本発明に係る複共振アンテナの基本構成を示す構成図である。

【図２】図1に示す複共振アンテナの等価回路図である。

【図３】本発明に係る複共振アンテナの具体的構成を示し、（Ａ）は平面図、（Ｂ）は（Ａ）の一点鎖線Ｘ－Ｘに於ける一部断面側面図である。

【図４】本発明に係る複共振アンテナの他の構成を示す一部断面側面図である。

【図５】本発明に係る複共振アンテナの更に他の構成を示す一部断面側面図である。

【図６】本発明に係る複共振アンテナの他の構成を示す部分平面図である。

【図７】本発明に係る複共振アンテナの他の構成を示す部分平面図である。

【図８】本発明に係る複共振アンテナに用いるチップアンテナの斜視図である。

【図９】本発明に係る複共振アンテナの更に他の構成を示す部分平面図である。

【図１０】本発明に係る複共振アンテナの更に他の構成を示す部分平面図である。

【図１１】本発明に係る複共振アンテナの更に他の構成を示す部分平面図である。

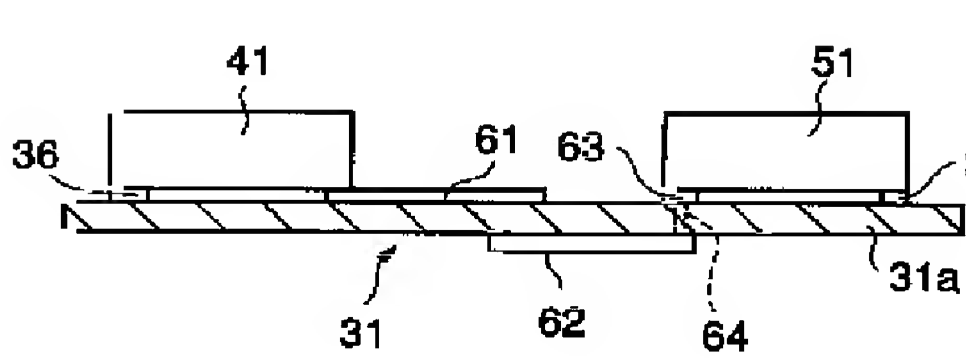
【図１２】本発明に係る２連式複共振アンテナの構成を示す平面図である。

【図１３】従来の複共振アンテナを示す斜視図である。

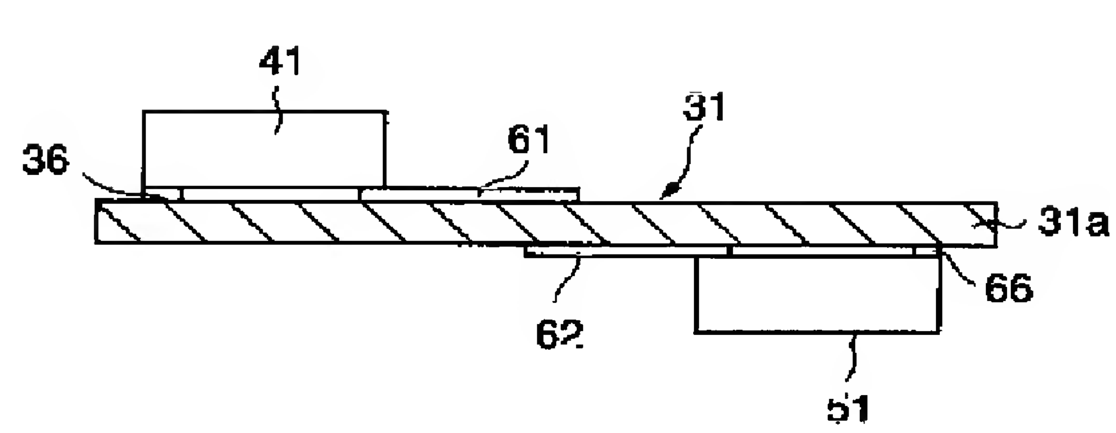
【符号の説明】

１０，３０　複共振アンテナ
１１　給電励振子
１２，２２，４２，５２　放射電極
１３，２３，３２，３３，６１，６２，６８，６９　電界結合パターン
１４，２４，４４，５４　電界結合端子
１５，２５，４７，５７　開放端部
１６，４６　給電端子
１７，２７　開放端容量
１８　給電回路
１９，７７　インダクタ
２０　信号源
２１　無給電励振子
２６，５６　接地端子
２８　接地回路
３１　回路基板
３１ａ　アンテナ形成部
３１ｂ　グランド部
３４　給電パターン
３５，７４　接地パターン
３６，３７，６６　固定パターン
４０　チップインダクタ
４１，５１　チップアンテナ
４３，５３　基体
４２ａ　平面部
４２ｂ　ミアンダ形状部
４８，５８　固定端子
６３　中継パターン
６４　スルーホール
７０　コンデンサ
７１　電極パターン
７２　連結パターン
７３　インダクタンスパターン
７４ａ　湾曲部
７５　給電引出パターン
７６　接地引出パターン

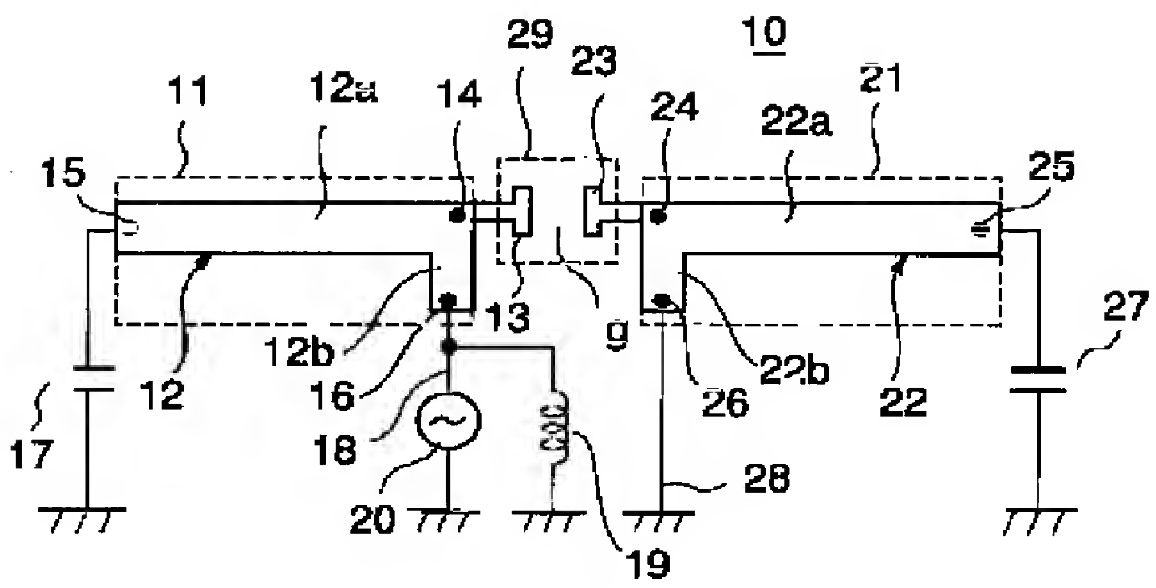
【図４】



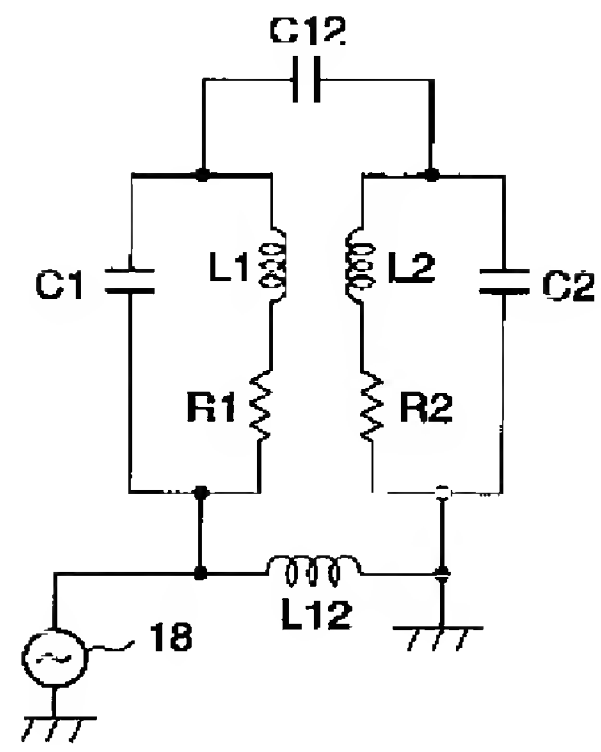
【図５】



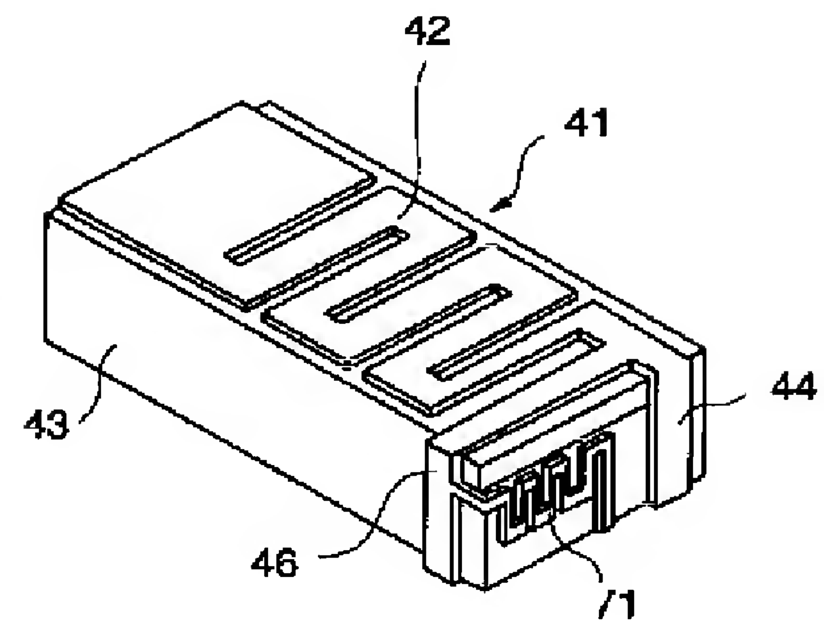
【図1】



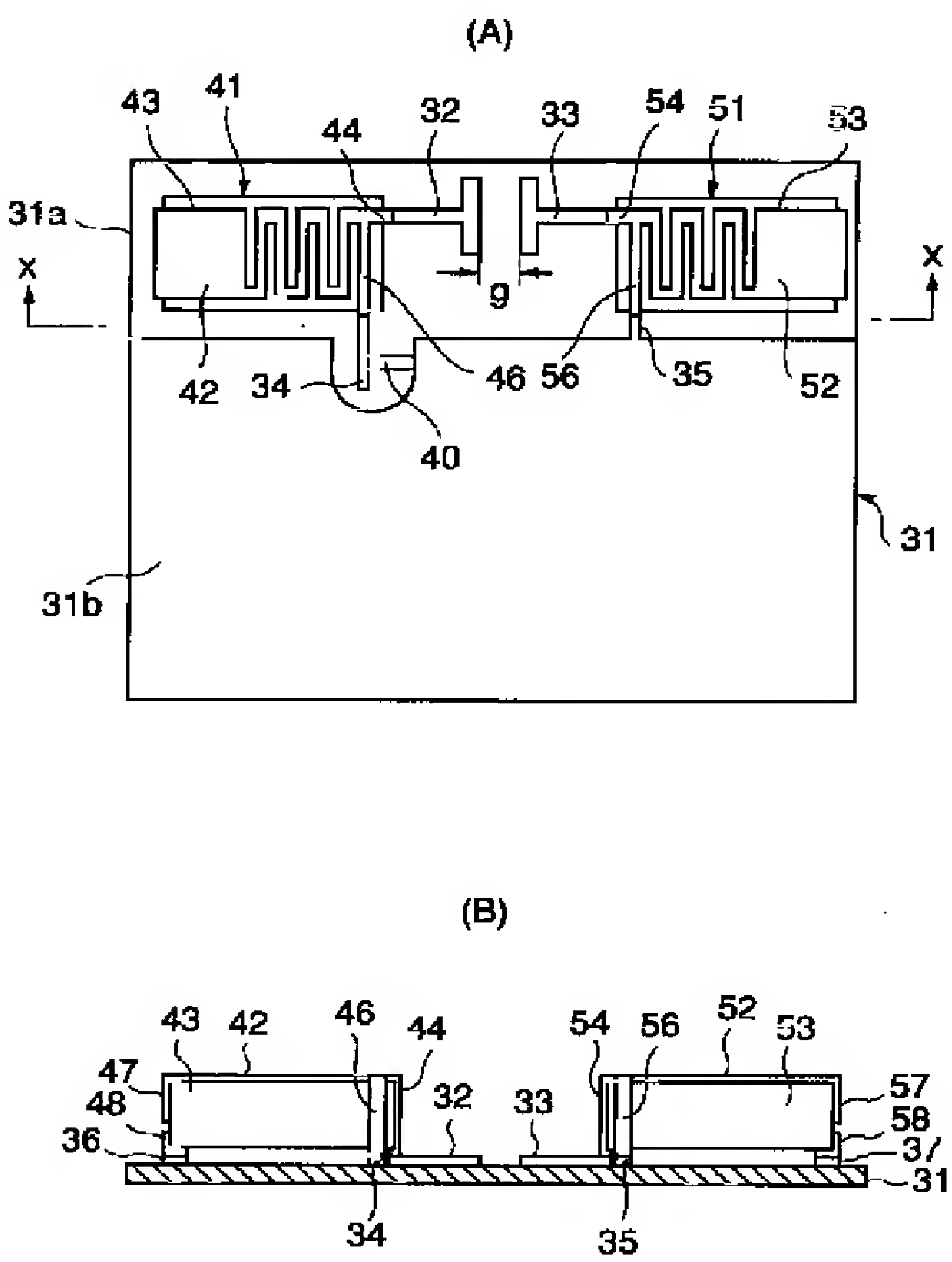
【図2】



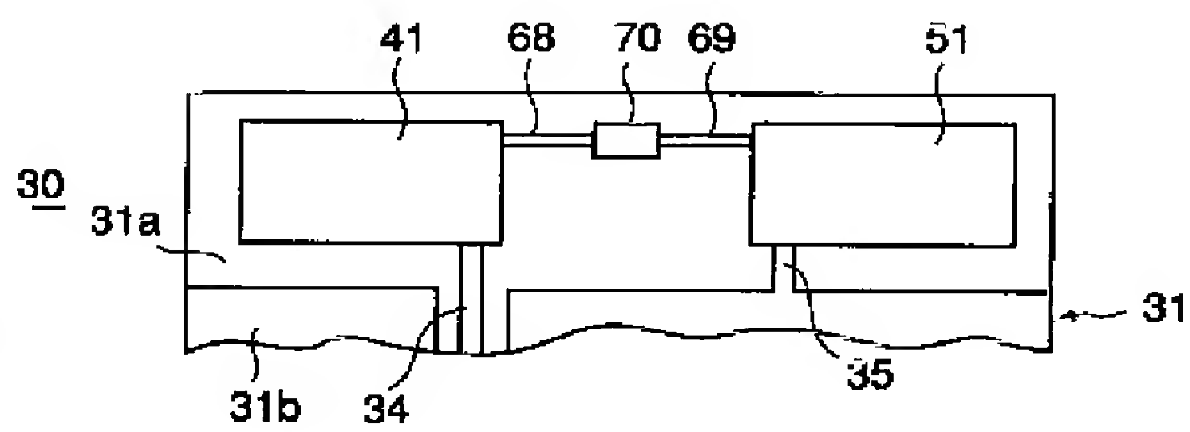
【図8】



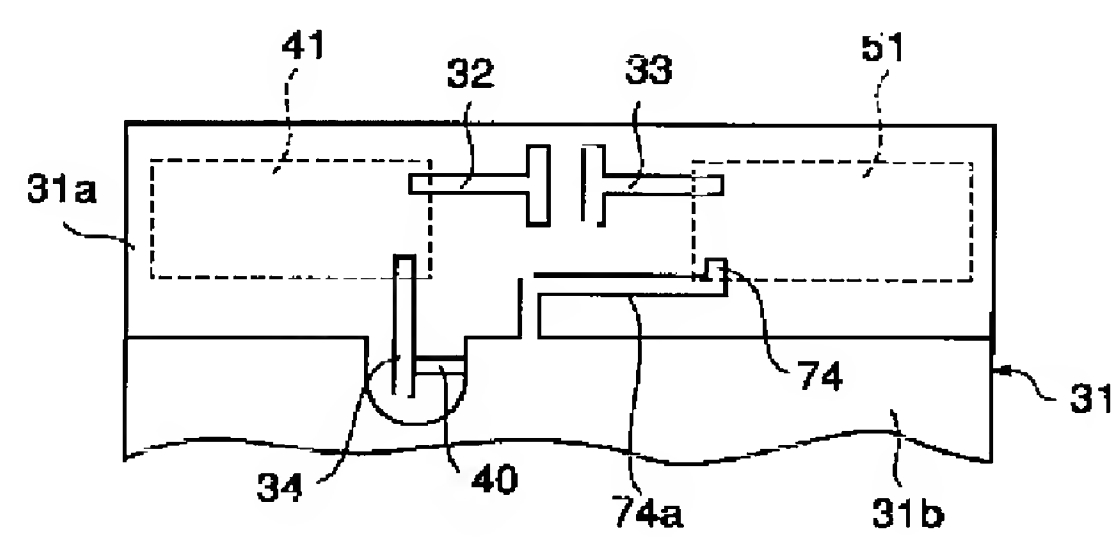
【図3】



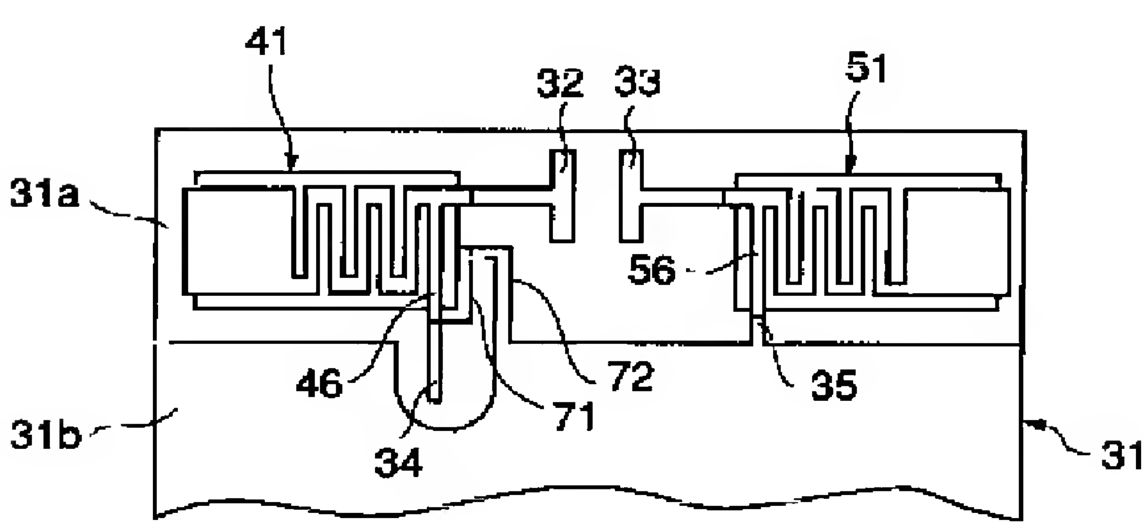
【図6】



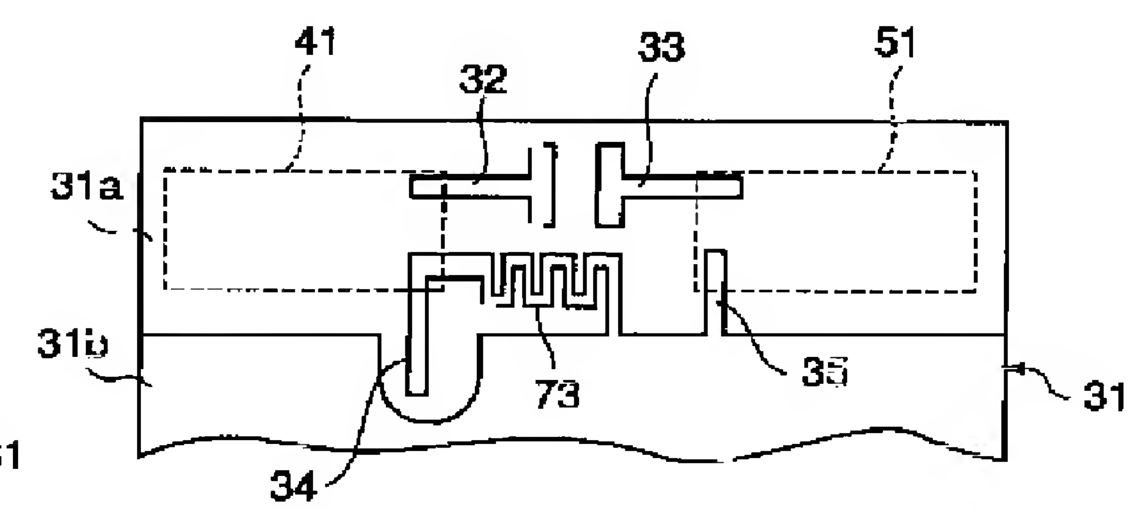
【図10】



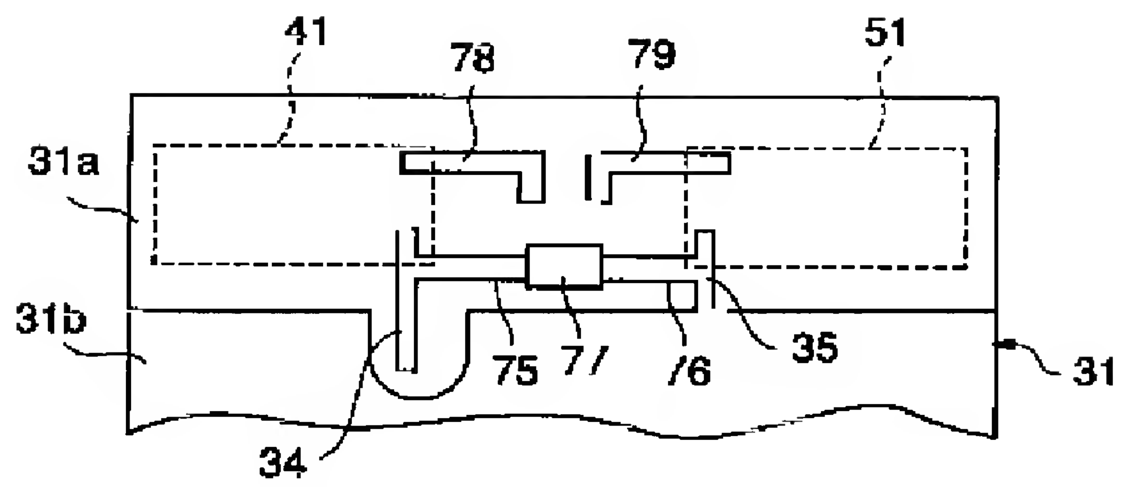
【図7】



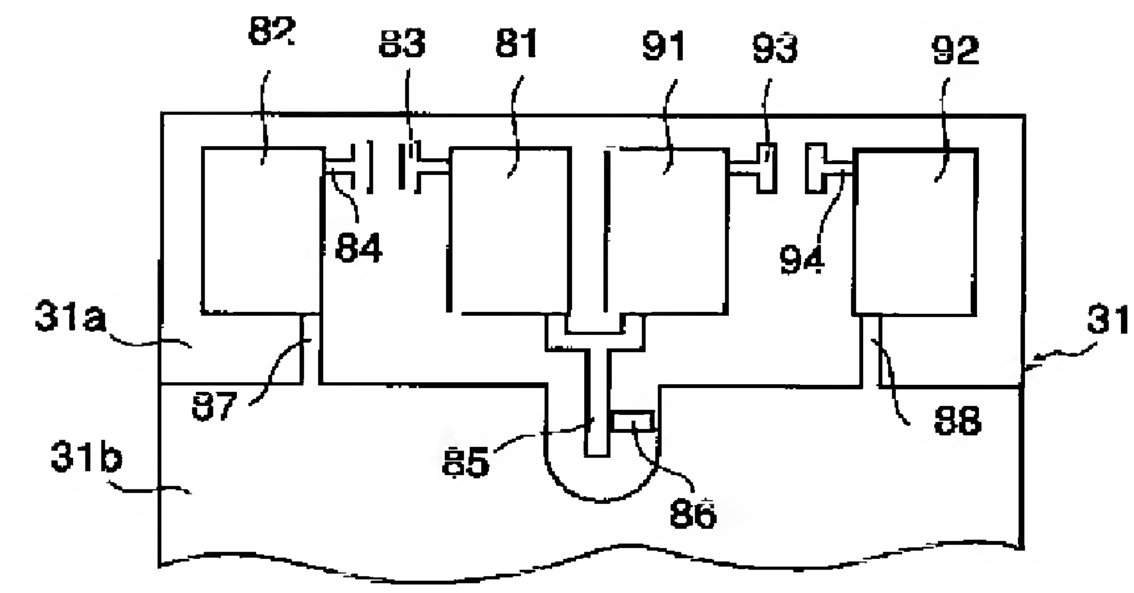
【図9】



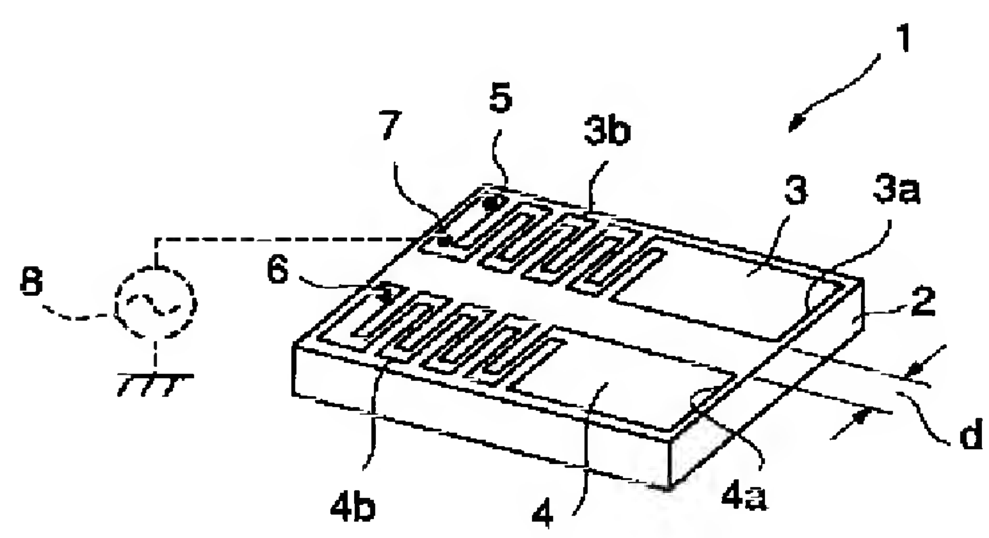
【図１１】



【図１２】



【図１３】



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Ｆターム(参考)　5J021 AA02 AA09 AB06 CA04 GA08
5J045 AA02 AA03 AB06 DA10 EA07 FA02 HA03
5J046 AA04 AA09 AB03 AB13 PA07